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ABSTRACT

This collection of conference papers by nine different authors deals with the following topics: (1) philosophy of educational management; (2) systems concepts and development, and the systems approach; (3) management information systems in education; (4) cost-benefit analysis; (5) educational resource management; (6) systems approach to project management; and (7) procedural aspects of PERT Time Analysis. A list of participants' names and adresses is appended. A related document is ED 041 400. (Figure 6 on page 138 and figure 7 on page 140 may reproduce poorly.) (LLR)

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PROCEEDINGS OF THE EDUCATIONAL MANAGEMENT TOOLS TRAINING PROGRAM

1969–1970

AT SOUTHERN ILLINOIS UNIVERSITY
COLLEGE OF EDUCATION
SCHOOL SERVICES BUREAU
CARBONDALE, ILLINOIS, 62901

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FOREWARD AND ACKNOWLEDGEMENTS

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Each instructor's presentation was taped during the January 1970 weekly institute. His presentation was then transcribed and edited by our staff. This draft was sent to the speaker who further edited the material into the present published form. If there are errors, the responsibility must lie with the editor.

It should be noted that the presentation by Dr. William Curtiss has been revised to reflect the changes and up-grading of the Educational Resource Management Design which have taken place since the January session. As noted in the text, the final schemata will be made available by the Research Corporation when it is completed.

Also, the material herein should not be reproduced without the expressed permission of the individual authors or the U. S. Office of Education.

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Dr. Thomas Purcell
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Dr. Robert Schellenberger
Southern Illinois University

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John W. Jones
Program Administrator and Editor

INTRODUCTION

Many changes, two decades or less in the making, have combined to produce a new and much different world, a more dynamic technology, and a revolutionary social order. Educational implications now and in the years ahead are equally challenging and clearly require vigorous educational leadership. The decade of the fifties marked the beginning of an effort to improve the professionalization of educational administration under the leadership of the Cooperative Program in Educational Administration. Other research efforts by universities, educational agencies and special projects have developed techniques for managing school systems which must be made available to practicing administrators.

The gap between the promise of education and its attainment continues to increase and is of grave concern among professional educators and enlightened citizenry. Secretary Gardner issued a challenge to educators when he stated:

> . . .educators . . . become not only teachers of their students but teachers of the nation in the new philosophy of learning and living in an ever changing world (and) . . . that they . . . convince the American people, once and for all, of the truth of Toynbee's (statement) that "civilization is a movement and not a condition, a voyage and not a harbor.[1]

The causes are not new but the implications for rapid change in school management procedures should not be ignored. Practicing school administrators need to be trained in the procedure of how to apply the methodologies recently developed by modern technology, i.e., systems analysis, management information systems, planning programming budgetary systems, and program evaluation review technique.

The term "educational planning" is being used increasingly at various levels of education in local school districts, state educational agencies, and other educational agencies throughout the nation. Edgar L. Morphet has written that:

> Planning is not a process of speculating on probable developments and preparing a theoretical blueprint for meeting needs. Rather it is a process of attempting to determine appropriate goals and objectives, obtaining and analyzing pertinent information that will bring into focus present and emerging problems and needs, and obtaining agreement on steps and procedures that are designed to meet those needs and so objectives can be attained.[2]

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[1] Gardner, John W., "Impact of Change on Education," NEA Journal, November, 1959, p. 51

[2] Morphet, Edgar L., "Planning and Effecting Needed Changes in Education," Report Prepared for the Third Area Conference, Designing Education for the Future: An Eight-State Project, Denver, Colorado, June, 1967, p. vii.

Educational research and planning is being viewed as import means for achieving the short and long-range objectives of the institution. Several factors have complicated the effectiveness of educational planning since the end of World War II. They are:

1. A rapid growth in the school age population.
2. Recognition that education is an important instrument for attaining national, regional, state and local objectives.
3. The increasing size and complexity of the educational organizations.
4. The expanding need for adoption of new innovations in educational institutions.
5. The increased costs and need for greater financial support to improve and expand educational programs.

To aid in the solving of the problems presented by increased size, complex operations, and limited resources, educators need to adopt new and modern methods for effective planning. These new methods should be brought to the attention of educational leaders in order that he will have available: (1) the tools that can provide a quick assessment of alternative courses of action, (2) the procedures to measure progress toward the achievement of objectives, and (3) the methodology through which growth and change can be directed and controlled.

Much work has been done to analyze specific aspects of educational activities and individual resources, however, very little concerted effort has been made to deal with problems within the context of a complete system. Systems theory approaches the problem from a universal or global approach and thus seeks to conceive problems in their full complexity. Systems theory is an approach which offers a technology for problem solving and decision making. John Pfeiffer wrote that:

> The system approach can be regarded as a disciplined way of using specialists in a variety of fields to analyze as precisely as possible sets of activities whose interrelationships are very complicated, and of formulating comprehensive and flexible plans on the basis of the analysis.[3]

In the past, planners have been frustrated in their efforts because of the great number of possible alternatives, the complexity of the interrelationships among programs, and the uncertainties of the probably overtones that exist in the various combinations of the program elements. Educational institutions have not had the availability of trained personnel to comprehensively analyze the effect of alternative policy decisions. Effective planning is not possible without a technology that can relate simultaneously all aspects of educational institution operation and feasible alternative courses of action.

---

[3] Pfeiffer, John, New Look at Education: Systems Analysis in our Schools and Colleges. Odyssey Press, Poughkeepsie, New York, 1968, p. 2.

The major objective of the training program was to develop within the research and educational leader the practical working skill needed for application of system theory and management techniques to their operational responsibilities. Subordinate learning objectives were:

1. Define what is meant by system analysis and list the basic steps related to system analysis procedures.

2. Define the meaning of the Management Information System (MIS), list the major component parts of an educational management information system and list the basic steps in implementing an MIS in practice.

3. Define Program Planning Budgetary System (PPBS) and list the component parts of PPBS and describe various implementation considerations.

4. Define Program Evaluation Review Techniques (PERT) and list the basic elements of PERT and prepare a PERT network from a simulated problem situation.

Three intensive training institutes were conducted for the purpose of imparting knowledge and information concerning general system theory concepts to persons in educational research leadership roles. Specific emphasis was placed upon the process of translating theory into techniques, products and organizaitonal patterns that can be of immediate use to the educational research leader. Concentrated efforts were made to join theory with fact as well as to reinforce the relationship between the ideal and real situations. This proceedings document provides the major content of these intensive training institutes.

Sam W. Bliss
Program Director

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PRESENTATIONS

TOWARD A PHILOSOPHY OF ADMINISTRATION-MANAGEMENT

Nelson Haggerson

My assignment at the three workshops on management tools was to give an overview of systems analysis that would relate a way of thinking (systems analysis) to the solutions of administrative and management problems.

It was my hope that the presentation would provide a frame of reference from which both presenters and participants could give meaning to the events of the week. In my endeavor to accomplish this task, I have developed a set of relationships which, when refined, might lead to a philosophy of administration-management. Hence, the title, "Toward a Philosophy of Administration-Management."

Definition

Management. For purposes of this paper I am not going to differentiate between administration and management as some authors do, and as I might under different circumstances. I will use the term management rather than administration-management defining it as: The art and science of planning, organizing, motivating, controlling human and material resources and their interaction in order to attain a pre-determined objective.

Philosophy. I will define philosophy as a set of relationships whose reason to be derives from the problems faced by those who order the relationships. Philosophy, aside from deriving from problems or reactions to other philosophies, is characterized by a set of values that rather consistently permeate the relationships. Furthermore, it is characterized by a methodology by which problems are systematically attacked and solved. And, for our purposes here, I shall add an application, the various roles played by managers.

Problems

The problems with which managers in the field of education are confronted vary from the larger ones of the goals of education and schooling to the minute details of getting a piece of chalk into the hands of the classroom teacher. As a matter of fact, whether or not managers should be involved in the formulation of educational goals is an issue in itself. There is probably little doubt that they should be responsible for defining goals into behavioral terms and for implementing them, but there is doubt as to their role in actually deriving the substance of the goals. Once a decision is made concerning goals there comes the tremendous task of deciding how to implement them. What education is appropriate for whom? How much education is appropriate? How shall it be organized? Schools, classes, groups, etc.? In what sequence should the experiences be ordered? The same sequence for all? How long should experiences last? What does it take in terms of human and material resources to carry out the educational goals established? How do we know about the effectiveness of the programs we design? These, along with a myriad of other problems, face the manager of today's educational enterprise. In philosophical terms these questions might be called substantive problems. Once a decision is made about the substantive problems the matter of implementation becomes an issue. How do we institute a program with the least amount of cost to fulfill the goals? How do we motivate teachers and other school personnel to carry out programs? This whole series of educational problems may be entitled procedural problems. Educational planning centers around the solution of both substantive and procedural problems. Their solution is at the heart of the manager's work, and hence at the heart of a workable philosophy of management. In the 1960's and 1970's, to say nothing of the 1980's these problems are complex and difficult to solve. Therefore, they are demanding of our better efforts.

Values

There are a number of values that seem to dominate the operation of an educational enterprise in the present day. While many of these values center around the individual, his rights and responsibilities, they also focus on the needs of the larger society. This very fact (the focus on both individual and society) provides conflict: As I study the situation, read the literature, and observe the behavior of both the policy makers and the policy executors I find a number of values consistently proposed as guide to the management process.

The notion of relevancy is foremost on the tongues of most educators today. Indeed, it is a main issue raised by critics of education as well as students. The curriculum should be relevant, instruction should be relevant, buildings should be relevant, the educational enterprise, itself, should be relevant, more relevant, if it is to be good. Determining what is relevant to which people and at what time is one of the problems to be solved. But that education should be relevant seems to be a well accepted value.

Effectiveness is another value which seems to be accepted by most. That a program should do what it is established to do, or that a teacher or educator does the job he has set out for him is a quid pro quo. Two allied values are accountability and efficiency. That the educator is accountable for the effectiveness of his school and that his operation should be an efficient one is cognitively accepted, even if not carried through in many cases. The laws requiring that public accounts be audited is a fact manifesting the value of accountability. The fact that the government is now cutting off funds from schools not enforcing the integration laws is another manifestation of the accountability value. Efficiency permeates our western economy, and while it hasn't met with much success in the educational enterprise, partly because of its complexity, it still stands as something to be desired. Often managers talk about these values in Time-Cost-Performance terms.

In our fast changing society world the need for constant change seems apparent, so apparent that the value of modifiability is the watchword of most educators, albeit its manifestation in behavior is sometimes hard to find. We must modify our educational programs so that they are meaningful to the learners for whom they are designed. The actual modification of educational programs is once again in the problem domain of the manager of the educational enterprise.

Other values that are related, but are different, too, are the quantity and quality of educational output. That is, we are concerned with the number and the quality of learners produced by the schools. The quantity is directly related to available money to operate on, the quality is becoming more of a measurable item. Accrediting associations, for instance, attempt to measure the quality of the product, or at least of the programs offered by schools. Once again, while few would argue that quality is essential, few agree on what characterizes it or how it is arrived at, much less how it is measured.

While there are many other values that seem appropriate to a philosophy of management, the last one I will discuss is that of cooperation, cooperation with other agencies, other disciplines, cooperation within the institution of the school itself. All are desirable relationships if we are to manage an effective school or educational enterprise. Cooperation may take many forms--in fact, it hasn't taken many forms--but the potential is there, and it seems mandatory in view of the complex problems the educator must solve.

Synthesis

Having briefly discussed the problems which the manager faces and the values which permeate the developing philosophy of management, I now present a schema through which I hope to synthesize my thoughts on a philosophy of management:

FRAMEWORK FOR A PHILOSOPHY OF ADMINISTRATION-MANAGEMENT*

Objects	Operations	Policies	Philosophical positions
1. THINGS	Logistical functions	Policies of efficiency	(Probably not required)
2. LAWS	Executive functions	Law: school board rules, regulation, hierarchy-policy, program, curriculum, instruction	Theory of implementation: Strict-loose interpretation
3. PEOPLE	Human relations	Personnel: 1. One's self 2. Students 3. Staff-Supt.-Board, 4. Society	1. Personal philosophy 2. Theory of human nature,of learning, behavior 3. Theory of leadership (plus 1,2) 4. Social theory (plus 1,2,3)
4. IDEAS	Ideational function--thoughtful deliberation	(Logical consistency)	Theory of knowledge Theory of philosophy Philosophy of Education Any thoughtful consideration determined only by the philosophical method

---

* The schema was originally presented by Ralph Hallman - Claremont Graduate School

It appears that we can classify the management domain in a four-by-four conceptual model. In the left hand column appear the objects with which the manager works: things, laws, people, and ideas (you may think of others). In the next column the operations which he performs on the objects; in the third column the policies which guide these operations; and in the last column, the philosophical positions which justify these policies and, hence, actions.

It must be emphasized that the model is presented as an oversimplified way of looking at management. It does not depict many of the relationships which may exist. It must also be emphasized that in any one decision about the objects with which the manager works there may be a multitude of interrelated decisions which bring into play every area of the schema.

By way of further explaining the model, and at the same time introducing systems analysis into our discussion I go to the cell on the idea row under the philosophical positions column. This is the cell in which I want to introduce a methodology appropriate to the philosophy of management under discussion. Certainly if the manager is to solve the complex problems with which he is faced he needs a comprehensive way of thinking, "an approach that represents a disciplined way of using specialists in a variety of fields to analyze as precisely as possible sets of activities while interrelationships are very complicated, and of formulating comprehensive and flexible plans on basis of analysis..every case representing a basic effort to reconcile objective and resources to achieve clearly specified compromises between what we want and what we can expect to get..." a methodology that will help people make decisions. You will note that this definition of a methodology is consistent with the value positions taken earlier.

I will consider systems analysis, then, as a way of thinking which contributes to the solution of managerial problems. Systems analysis as a way of thinking is identified by four main characteristics· A way of asking the right questions, of defining objectives in precise terms; a way of seeking alternatives (No single answer is acceptable. Rather, the emphasis is placed on selecting the most appropriate alternative from a number of acceptable ones.); continuous feedback used for evaluation purposes (Evaluation becomes a repetitive process which allows appropriate kinds of changes to be made at appropriate times); and, finally, a way of thinking that is appropriate to many disciplines and allows for an interdisciplinary approach to management problems. (In this sense, systems analysis is a method of methods, or as Kaplan describes it, a methodology as contrasted to a more limited method.)

By way of further development of the schema, let us examine the systems analysis approach to a solution of a problem having to do with people. Suppose the problem is finally defined as one of developing a policy to guide relationships between the students and the administration. (A systems approach--force field analysis--can be used to arrive at the place where you determine that the problem is to develop a policy.) The objective of the policy must be clearly stated in terms that can be manifested in behavior. Alternative positions can be taken depending upon philosophic positions on human nature, on leadership, etc. Once a number of policies is derived the feasibility of each can be determined, the cost of implementing the policies can be determined, the barriers to carrying out each can be projected. A single policy is finally selected, but provision is made for immediate and continuous feedback pertinent to implementation.

With this feedback, decisions can be made about amending the policy, continuing the policy and other alternatives. The important thing is that the methodology used provides for: a clear statement of objectives, derivation of alternatives, and provision is made for continuous evaluation to allow for correction. The fourth characteristic of systems analysis is that of an interdisciplinary approach. Hence, resources from the field of law, sociology, psychology, etc., can be brought to bear on the formulation of the policy, as well as its implementation and continuous re-evaluation.

While evaluation is not a new notion or practice in education the constant change in programs as a result of evaluation is a new phenomenon to most in the educational enterprise.. This built-in correction device may be the most important contribution of systems analysis to education. By using systems analysis as a way of thinking that contributes to problem solving and good decision making one can examine the entire schema presented to elicit more and more implications and to see the real power of systems analysis.

Model Building

While I have described systems analysis in general terms, and the speakers during the rest of the work shop will handle many of the detailed aspects of systems, I would like to discuss the concept of model building as an integral part of this way of thinking. A model is a simplified but controllable version of a real world situation designed to facilitate thinking and understanding. I'll briefly discuss three different kinds of models. There are many other kinds.

Conceptual models. A conceptual model is designed to show relationships between knowledge areas already delineated. The schema presented in this paper is a conceptual model. It provides us with a way of explaining relationships, with catagories into which to classify data, knowledge, ideas, and information. PERT charts represent another conceptual model.

Simulation models. Since systems analysis forces us to make decisions based on alternatives, we need help in deciding which alternative is most feasible taking into account cost, time, experience. The simulation model, especially when programmed for the computer, can provide us with valuable information. One use currently made of simulation models is in school district reorganization. By programming the various alternatives available and feeding them to the computer, we can determine which form of reorganization will be least costly and consume less time to implement, among other things. Decisions can then be made as to which alternative fits the pre-determined criteria without having to try each alternative out in reality. Similar simulations can be done with school schedules. While the computer is not absolutely necessary, it provides many answers in a short period of time. It can handle so many more variables than we could before computers that the outcomes of our simulations are probably more realistic, too.

Another kind of simulation model is the gaming model. We have wondered how vicarious experiences could actually contribute to the thinking process. The many games on the education market now are simulation models designed, in most cases, to provide meaningful, yet simulated, experiences. There is a great deal of work to be done in this area, but there is much to be optimistic about. The simulation models actually make systems analysis, as described earlier, a workable thinking model because they allow for the consideration of many alternatives--something that has not always characterized education of decision making.

Theoretical models. It must be stated that both conceptual models and simulation models are versions of the real world situation, as is a theoretical model. The latter, however, is designed to allow the best possible predictions about what will happen in the real world. A theoretical model is made up of a system of hypotheses which are to be, or have been, tested in the real world and which allow accurate predictions to be made. Having developed a conceptual model, tested it via a simulation model, we can then hypothesize that certain things will work in the real world. We test out these hypotheses, and as we verify them or reject them we bring our theoretical model closer and closer to reality. (It is paradoxical that in the minds of some a theoretical model is far from reality--the theory-practice dichotomy--but as it is used here the theoretical model is the most vivid picture of reality we have.)

All three of these models play an important part in systems analysis as a way of thinking.

Issues

I have presented the basic elements of a philosophy of management; definitions, the problem milieu, a set of values, a way of thinking, and a conceptual model to show the relationships. I have yet to discuss the roles managers might play in the management of the educational enterprise. First, however, I want to present some issues related to the above comments. The fact that some of the ideas presented are still in issue form is the essence of my concept of "toward" a philosophy of management. We still have many issues to settle.

One of the most important aspects of systems analysis as a way of thinking is self correction, constant evaluation and change. While a way of thinking is much more stable than the substance about which thinking is done, it too needs constant evaluation--a built-in correction device. I am concerned that we may narrow systems analysis down to such a well defined model that we don't provide for change in the thinking model itself.

Another issue, or perhaps just a concern, is that on the one hand we commit ourselves to the need for preciseness in the use of language as part of systems analysis, but on the other we currently use several different systems languages. There is a need, as Fred Bellott says, for a thesaurus of terms applied to systems analysis. The mathematics educators found the same problem in the early days of "modern" mathematics. They espoused the need for preciseness in the use of language, but they could not agree on precisely which terms applied and where.

Some writers have described systems analysis as "bounded rationality", depicting the limitations that one can deal only with those factors he can comprehend at one time. Another explanation of this criticism may be that systems analysis tends to be linear in its approach (as depicted by flow charts, etc.) and the whole world is not linear. Hence, a limitation. The main precaution is to recognize the limitations and to work on extending the boundaries.

Another precaution, and in a sense an issue, is that the systems analysis approach used by the industrial-military complex may apply to education in a very limited way. The tendency for educators to "get on the bandwagon" and accept without question something that has worked in another area may be a problem in adapting the industrial-military complex version of systems analysis to the solution of entirely different kinds of problems.

The last issue is actually in connection with the definition of management itself. As defined here, "the art and science of planning, organizing, motivating, and controlling human and material resources and their interaction in order to attain a pre-determined objective," certain ethical issues are implied. The objective of controlling and manipulating humans to attain predetermined (by whom?) goals is an ethical issue itself. In our fervor for effectiveness, efficiency, output, input, accountability, etc., we must not forget that human beings are not "things" to be manipulated.

Roles

While no one person is likely to be involved in all of the roles mentioned here, these are roles that seem important in carrying out the management function. Hence I will include them as important aspects of the philosophy of management described here.

The Scholar. The role of the scholar is that of researching, seeking answers to complicated problems, generating models, identifying alternatives, and proposing solutions.

The Planner. The planner identifies major and subordinate objectives, presents them to the staff, considers equipment, data, facilities, services and makes decisions.

The Organizer. He establishes a plan designed to reach major and minor objectives. He establishes work tasks, sequence and dependency among tasks, along with performance standards or quality control. "The goal is to achieve an optimum balance between schedule, costs, and performance requirements."

The Motivator. He communicates project goals, directs assignments of tasks, provides leadership, assesses staff morale, insures involvement.

The Controller. He engages in the process of responding to deviations from schedules derived in planning, organizing, and motivating.

And in my opinion most importantly:

The Rebel. Since the system is open to alternatives and constant change, there emerges the role of rebel--an ombudsman (or whatever name you apply to one)-- who keeps the system from jelling in some form of complacency.

There are no doubt other roles in the management of the educational enterprise. These few mentioned seem, however, to fit into the philosophy derived and to be consistent with the values accepted.

Summary

In summary, it is suggested that it may be helpful to work toward a philosophy of management. That philosophy includes a definition of terms, a realm of problems, a set of values, a methodology with which to solve problems, and definition of roles in which managers engage while administering the educational enterprise. It also includes a number of unresolved issues which keep it viable and subject to change as change is needed, and as new data are available. Systems analysis is a way of thinking

that is proposed as a methodology compatible with the philosophy of management presented in this paper.

SYSTEMS: THEORY AND CONCEPTS

William Gould

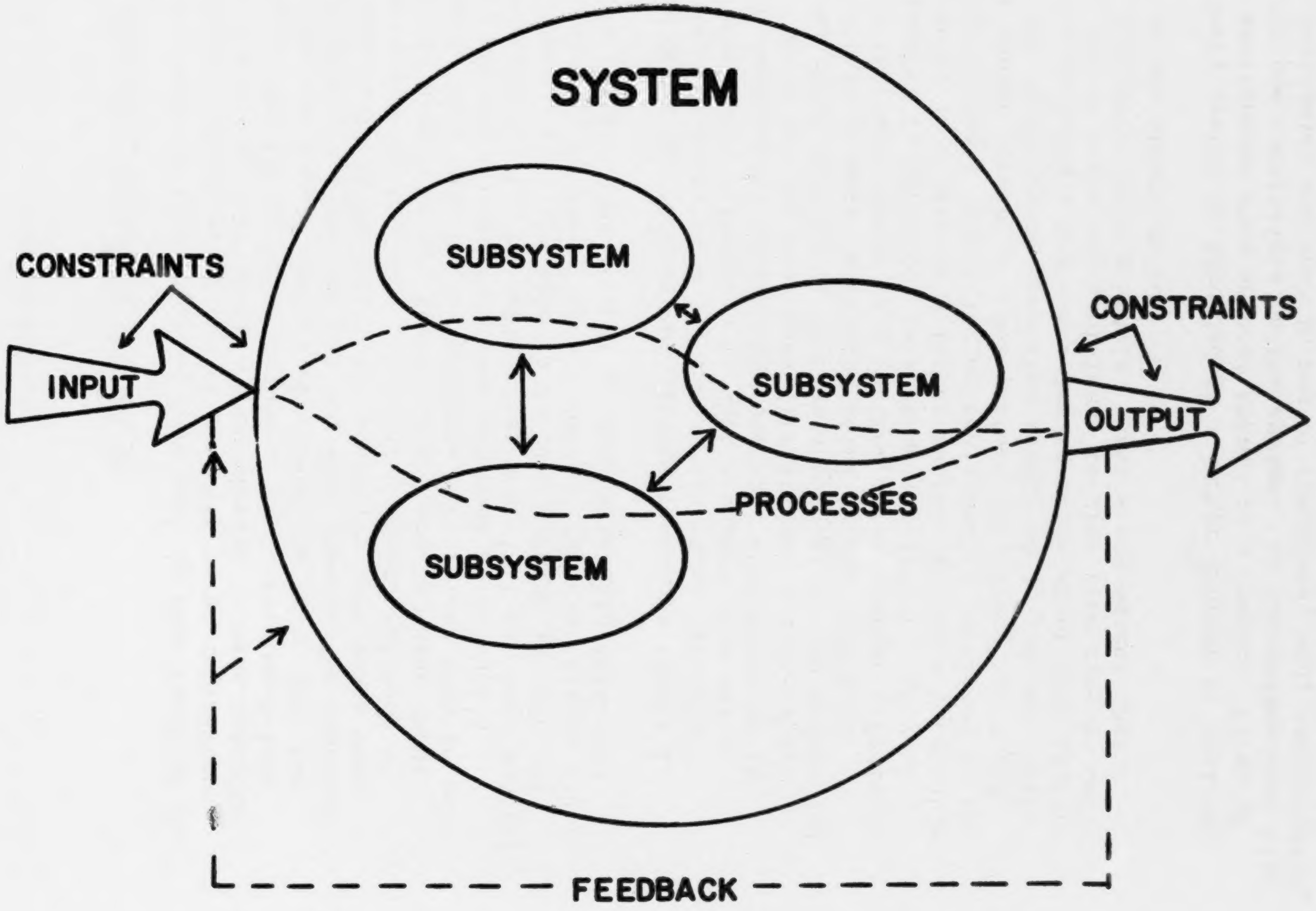
Discussion of Handouts - Figures 1 through 1e

I think my essential feeling about "systems" is that there is no one systems approach, there are a lot of very different definitions, it's become an "in" word, I think it's been misused in many respects and I think one of the things we're trying to do in this week-long session is to give you a wide variety of viewpoints as to what the approach is all about, how you can use it, what some of the mistakes are that have been made in the past, and hopefully give you a very brief exposure to some of the many different concepts and some of the tools that are used. We are trying to get you to think about what's being said, what some of the concepts are, relate them to your own experience, and try and make up your own mind as to what's appropriate and what isn't. Now this afternoon, I'll get into something of a prepared speech, what I'd like to do this morning is give you a few examples of what "systems" is all about. Perhaps talking about these first will clarify some of what we deal with this afternoon.

First, why don't you look at the diagram that says Figure 1, Systems Concepts, and along with it, the sheet headed "systems concepts". A very basic definition is that a system is a set of parts that work together to achieve the over-all objectives of the whole system. While you can find many definitions, I think that includes the essential elements. There's a purpose to the system and all the parts within it work toward the total system objective. I think the point that was raised here earlier about whether efficiency is a valid objective in education is extremely relevant. If your particular activity is a part of a larger system, it seems reasonable to ask for example, "am I conducting my registration operation in the most efficient manner possible?" But perhaps efficiency isn't the criteria that the registration operation should be judged on. Maybe you need to give students a lot more time to think about what courses are available, and if there are conflicts, to give them time to work them out - to reshuffle their schedule. That's one aspect that I think we need to pay attention to.

Second, every system is embedded in a larger context or environment, and the environment does several things to a system. First of all, it provides the constraints on the system. It determines what kind of inputs are available; how much in way of resources, men, and material, money, etc. are available for the system to operate effectively. It also helps determine what the objectives of the system are. So the constraints are factors in the environment which affect the system, but over which the system itself has very little control.

FIG. I SYSTEMS CONCEPTS WITHIN THE ENVIRONMENT


SYSTEM
CONSTRAINTS
INPUT
SUBSYSTEM
SUBSYSTEM
SUBSYSTEM
PROCESSES
CONSTRAINTS
OUTPUT
FEEDBACK

Another aspect of systems is that they employ feedback. This is a sensing of the system's output, it's performance; a comparison of this output with system objectives through some kind of an assessment measuring device, and initiative of corrective measures to bring actual output closer to the desired. On the diagram I've symbolized feedback as coming from the output and being used to modify the input. It also can modify how the system is organized, and what the processes are that are going on within the system.

There are relationships among components in a system, between one system and another, and between the system and it's environment. And there are processes of change occuring within and outside the system. The system scientist, designer, or manager has to be sensitive to all of these factors.

I've listed a couple of strategies that are useful in analyzing, managing, and designing systems. They are two of many kinds of very different approaches possible. One I've called a visionary strategy where you try and sit down and ask "what's the ideal kind of system that I want?" In the ultimate, how should this work. Based on that, you try and design the elements, the processes, and the inputs--how they're transformed and changed--to develop a system that you feel is ideal. Having done that, you ask, "where are we now, how far from this ideal are we, and what is it we have to do to develop this ideal system?" This approach is useful for breaking out of ruts and for getting out of the traditional way of thinking, because when you begin to think about the ideal you should ignore where things are now. Ignore the present organization, the present structure, the present myths and rules and regulations. But one problem with this kind of approach is that it tends to reinforce the idea that there is an ideal and that if you can just attain it everything will be great. My particular bias says that there really isn't an ideal and it is perhaps best in many situations not to take this approach. So to me, the second approach, the evolutionary approach, is in most cases more realistic and a more viable concept. Essentially what you do here is try and identify what the performance objectives are that you want to achieve, develop criteria and ways of measuring system performance, and then try and take a look at where you're at and how you can improve present and existing systems to come closer to meeting your objectives. In other words, what is suggested is a continual process of change and evolutionary growth, one of modification and improvement. That very briefly is one way to look at the notion of systems and a part of this that is important to keep in mind is that the system we represented with a circle here is just another system within a larger super-system and that's within a larger one. As we get into your lunch assignment, I think you'll begin to appreciate some of the difficulties in designing systems that are within larger systems because very often the goals and objectives can conflict or it may not be clear what they are.

In the second set of documents you received entitled, The Systems Approach, I've tried to capsulize some of what I think about systems approach. Essentially it is that it is an attitude, a state of mind, a way of looking at problems. It demands holistic thinking. It calls for rationality and application in many respects of the scientific method. But above all it demands a tremendous curiousity and continual questioning. Why are you doing this? What are the objectives? Is this really the only way to do it? Just because it was done this way in the past, is that any reason to continue?

Quade has a definition here of systems analysis that I think gets into some of the essential features of the approach.

On the second page I've tried to summarize again from my biases what are some of the key activities in analyzing and designing a system. They're listed in step by step fashion, but they're not to be applied in that way. Typically you go through these seven steps and you continually repeat them. As you get into creating alternative solutions you may find out that your earlier definition of the problem was too limited or too broad or incorrect. So it's a continual process of going through these steps. I think in any document on systems you'll find a roughly similar, although often seemingly very different set of steps. So just view these seven steps as one operational tool to help remind you of the kinds of things to go through.

Finally, there is a bibliography and an abbreviated prospectus from Jere Clark, who's at Southern Connecticut State College. It's just a summary of what one of the task force groups in general systems research activity is trying to do in the area expanding information about general systems in the field of education. I think it would be worth paying attention to what's happening in that field.

Are there questions about any of this right now? Why don't we discuss the handouts for a few minutes, and then I'll try and outline what I'd like each of you to tackle during the lunch period.

AUDIENCE: How does Quade relate intuition and judgment to quantitative methods? Those in education ought to be interested today in the question can what Quade refers to as intuition and judgment be taught?

SPEAKER: Intuition and judgment? I'll avoid answering that by trying to say I think what Quade is saying is that for those who are experienced as you are as managers of R and D, as administrators, as teachers, and as educators, systems tools and techniques and especially modeling can help clarify your thinking. You have some experience in the field, you have some judgment, maturity, expertise. System tools can help focus your thinking, sharpen it, clarify your own knowledge and understanding of systems of education. And I think this is the sense in which Quade uses the terms. As to whether intuition and judgment can be taught, I'd say that's more appropriate from some of you to try and answer or struggle with. I guess my own feeling is I think they can be improved, they can be enhanced. I really don't know.

AUDIENCE: May I try you again on the next page entitled "Key Activities in the Systems Design and Analysis Process?" Because I'm really in a fog here at the moment. Wouldn't "definition of the problem" be the job of the philosopher in terms of what ought to be? Secondly, maybe our school superintendent could identify the constraints and perhaps alter the systems there in the problem solving process. Next the curriculum director will, out of what ought to be, identify objectives but the systems man will take number 4 and identify criteria for measuring and etc. And then the devils advocate or a Nelson mentioned, might be the guy who creates alternative solutions to all these questions so the systems men will say, well, there are other ways. And 6, analyzing and evaluating the alternative solutions. This would again be the systems man. The next, communicate. Boy, that's a big one, but, according to that, who would interpret it?

SPEAKER: Okay, I like that question. Again from my biases I would say it's extremely important that one individual or a team of individuals, if they are working very closely together, do all of these. In other words, you should not break up the elements.

AUDIENCE: Back to my first question about the assumption that the person who has intuition and judgement or he shouldn't be here.

SPEAKER: I'm still not clear at what you're driving. Let me try and respond another way. I think one of the difficulties in the way we have developed our society has to do with the fact that we tend to break problems into isolated parts and tackle them separately. We have different people designing different elements. Then we try and put them together and in the process we find they really don't fit together very well because we failed to take into account the interaction among elements. I think one of the key messages of the systems approach is that it's extremely important to try and tackle all of these steps yourself. You may not be an expert in some of the areas and it's a very difficult kind of thing to do. But this is why the approach can be very effective, because it forces you to get into these activities that you're normally not dealing with or perhaps you deal with them on a very subjective, intuitive level. Quade urges you to be explicit so that other people can understand your assumptions, your definitions and the process that you went through in arriving at your design or your decision about how to set up and organize and manage a system.

AUDIENCE: Does your position differ from the previous presentation (Nelson Haggerson's) different roles that have to be performed? Are these systems in conflict with each other? How would you react to the question that he reacted to right at the end where he was talking about the several roles that have to be performed?

SPEAKER: I think once you have a system in operation there are many, many activities that need to be performed that don't necessarily call for individuals with a wholistic approach. There are many specialized activities. I think it's very essential that a manager of a system, depart ment, or organization have a wholistic approach and that as many as possible of the people within the organization have this approach. But obviously there are many very specialized activities. So I would say there isn't a conflict in the sense that you only need systems people or you need many, many specialists--both are needed.

One of the characteristics of applying a systems approach is that it tends to be very frustrating and very threatening to the way people are presently doing things. For example. try to develop a heirarchy of different kinds of systems. Banathy does this in his book and it is one good way to look at it. Imagine that society is a super system and within it there are smaller systems--governments, educational systems, industry, and so on. You can also break education out and say education is the super system within which we have federal education programs, we have job corps, secondary schools, state departments of education, and so on.

What are the elements in a typical university for example? Each of these elements are systems within larger systems and one of the things that the systems approach is trying to say is that every individual should be concerned with what are the goals and objectives of the larger super system within which he is embedded. Banathy suggests that the goals and the processes and the kinds of inputs and constraints on a system, such as education, all come from a larger super system. Now that may be the case ideally, but I think in practice that really doesn't hold up. If you begin to look at what goes on in the University and try and take a look at ideal goals, maybe they have to do with quality teaching, inabling "x" number of students to somehow improve themselves or develop themselves. These tend to be the ideal, theoretical, aspiration goals. But how about some of the more realistic goals that actually operate? In many universities they have to do with buildings. We just want a nice looking physical plant. That may be one of the major goals of the president. Maybe it is national acclaim. Particular individuals within the university structure have very personal goals that may conflict with the system's teaching goals, e.g. earning more money, more time for research. So it is important to pay attention to not only what are the ideal goals of the system but to what is actually occurring at all levels.

I think some of these kinds of ideas and concepts will begin to jell and be more clear as we continue. What I would like you to do over lunch is begin to struggle with some of this. I've got some nice bright yellow paper here for you to do it on. Use the paper cross-ways, and answer these four questions: (1) what is your position? (briefly describe); (2) what is the immediate organization that you are in? (and briefly describe what it is all about); (3) what are the major subsystems, i.e., elements, departments, components within your organization, viewing it as a system?; and (4) what is the super organization within which your particular organization is imbedded?

For example, if you are a director of research, try and identify what your function is, your position. If you are head of the research bureau, what are the elements within this. You may have a computer center, you may have a testing service, field activity, etc. A larger organization may be the university itself. What I am trying to do is get you to think about the concept of systems whithin systems.

Then for each of these four heirarchal levels, identify the most important objectives or goals. Finally, what are the criteria that are used to measure attainment of these objectives in each of these four system levels.

Let's take as an example your being in charge of registration. Your objectives have something to do with enabling all students to fill out their schedule with the courses that they want and enabling the university and the professors within it to know who's scheduled in their activities. One criteria may have to do with registration efficiency--how much does it cost to conduct this operation? Another may be time--how long does it take? Another may be how effective is it in filling up the courses that are offered. Other criteria may be how does it handle overloads; is it able to be flexible enough to be able to work around overloads?

Let's take another example. Maybe your position is head of R & D. The objectives of the R & D function may have to do with bringing in more money for grants and research. Maybe that is the primary goal in this particular organization. Maybe it is also an objective to do high quality research. Maybe another objective is to expand research in a particular area. If brining in more research money every year is the objective, then maybe the criteria is simply some dollar volume or percent increase of research. If it increases by 10% every year, you are meeting your objectives. If is only 3% or 4%, you haven't done your job. If the objective has to do with expanding research in different areas, then the criteria would measure new areas of research added. If you haven't added any, you are not meeting your objectives. Now if you begin to get into some of the more practical kinds of objectives that are often only implicit, and this is where it gets rather hairy, maybe your particular head of the research organization is only concerned with himself, so his operational objectives have to do with publishing, getting on national committees, planning a higher-paying, larger power base type of job. If that's the real case, then his objectives may really not coincide with what the university thinks are the objectives of that organization. I think by struggling through this you'll begin to get an idea of how the approach tends to force you to think and examine very fundamental questions that may have been ignored. This afternoon, I think we can get together in smaller groups and try and take a look at what some of these responses are. Don't feel you have to put your name on it unless you want to.

This afternoon I've got a prepared presentation that may help to pull together some of the pieces. What I've tried to do here, in just this half hour is to throw out a few of some of the essential ideas to get you to begin thinking about this.

Figure 1a

SYSTEMS CONCEPTS

1. A system is a set of parts that work together to achieve the overall objectives of the whole system.

2. Every system is embedded in a larger context or environment.

3. Constraints are factors in the environment which affect the system and over which the system has little or no control.

4. Systems employ feedback--a sensing of the system's output; a comparison of this output with system objectives; and initiation of corrective measures to bring actual output closer to desired output.

5. There are interrelationships among components in a system, between systems and the environment, between systems and other systems, and there are processes of change occurring within and outside the system. The systems scientist, designer, or manager must be sensitive to all of these elements, interrelationships, and processes, and attempt to understand them.

6. There are many strategies and approaches for analyzing, designing, and improving systems. Each has its advocates; all are appropriate in different situations.

   a. Visionary strategy

      1) Identify ultimate objectives, where you want to end up in the ideal state; forgetting about existing methods, standards and traditions.

      2) Design the system processes, elements and interactions to achieve the ideal system.

      3) Determine what the situation is now, what resources are available, what constraints exist.

      4) Map out ways to get from the now state to the desired ideal system. This approach is useful for breaking out of ruts, of leaping out of traidional thought patterns. However, it tends to reinforce the notion there is an ideal, a perfect system, and it often turns out the system designed in this way if far from ideal because of unanticipated changes in the environment or in system goals.

   b. Evolutionary approach

      1) Identify system performance objectives

      2) Develop performance criteria and ways of measuring system performance

      3) Modify elements of existing system to improve performance

   This approach recognizes that we may not know enough to develop an ideal system, hence focuses on really understanding our objectives and system goals, and improving system performance through continual evolutionary change.

Figure 1b

THE SYSTEMS APPROACH

The systems approach is an attitude, a state of mind rather than a bag of techniques. It demands holistic thinking, rationality with recognition of irrationality and uncertainty, intellectual honesty, large doses of the scientific method, and above all, a continual stream of questions: Why? What for? Is there any other way? To what end? What if?

It is not a really new approach. There have always been holistic thinkers of this type and mode of working, but it is becoming more refined and clarified as a process and a discipline, more powerful as new tools and techniques are developed, and many more people are now adopting the systems view.

Quade's definition of systems analysis conveys much of the essence. He is describing systems analysis, which is just one aspect of the systems approach, but it is a key aspect.

> A systems analysis is an analytic study designed to help a decisionmaker identify a preferred choice among possible alternatives. It is characterized by a systematic and rational approach, with assumptions made explicit, objectives and criteria clearly defined, and alternative courses of action compared in the light of their possible consequences. An effort is made to use quantitative methods, but computers are not essential. What is essential is a model that enables expert intuition and judgement to be applied efficiently. The method provides its answer by processes that are accessible to critical examination, capable of duplication by others, and, more or less, readily modified as new information becomes available.
>
> Characteristically, it will involve a systematic investigation of the decisionmaker's objectives and of the relevant criteria; a comparison--quantitative insofar as possible--of the cost, effectiveness, risk, and timing associated with each alternative policy or strategy for achieving the objectives; and an attempt to design better alternatives and select other goals if those examined are found wanting.*

Figure 1c

KEY ACTIVITIES IN THE SYSTEMS ANALYSIS AND DESIGN PROCESS

1. Define and bound the problem(s)

   This will change as one goes through the process and really begins to understand the problem. Never accept blindly the problem as given.

2. Identify constraints on the problem and the problem-solving process

   Don't let constraints inhibit creativity or unduly box you in. Part of the process is to determine whether the constraints are valid or whether they can be circumvented.

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*E.S. Quade, Systems Analysis Techniques for Planning-Programming-Budgeting, The RAND Corporation, Santa Monica, 1966 (AD629564) pp 11 and 28.

3. Identify objectives

   There is usually a hierarchy. Which are most important, which conflict, thus calling for a tradeoff analysis?

4. Identify criteria for measuring attainment of objectives and evaluating system performance

   Clearly state assumptions and values that are operative. Be sure you know how to measure system performance. This is the most neglected activity and the most important not to omit.

5. Create alternative solutions

   Creative, divergent thinking is crucial here, so don't analyze at this point, stay open to wild, imaginative alternatives.

6. Analyze and evaluate alternative solutions against criteria

   Do this explicitly so that others can follow your analysis. Presenting several alternatives, even when one is clearly preferred, brings all decision-makers into the process you went through, and often elicits new and relevant information that will alter the analysis.

7. Communicate results of activities 1 through 6 to clients, decision-makers, and the total system team

   All involved should understand the overall process and should understand the rationale for a particular choice or decision.

8. Cycle through activities 1 through 7 as often as necessary

   The order is not crucial, for the whole process should be repeated many times because each activity interacts with all others. Each iteration of the process may alter the problem definition and the objectives.

Figure 1d

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Figure 1e

Abbreviated Prospectus

Task Force on General Systems Education
Society for General Systems Research

Identification

The Task Force on General Systems Education is the education committee of the Society for General Systems Research. The eighty members of this standing committee represent a wide variety of educational, governmental, industrial and military institutions from coast to coast, and most of the traditional academic subject areas (broadly conceived) as well as the various systems groups, including those in cybernetics, operations research, game theory, simulation modeling, and optimization theory.

The Society for General Systems Research is the only professional society devoted solely to exploration of the systems concept as applied to all fields of thought. The special emphasis of the Society is on developing interdisciplinary, isomorphic models each of which organically synthesizes several areas of knowledge. This non-profit, non-partisan agency evolved out of Section L (History and Philosophy of Science) of the American Association for the Advancement of Science in 1955.

Purpose

The general purpose of the SGSR Task Force is to cooperate with other systems groups in an effort to promote the general systems approach wherever appropriate in education generally, from kindergarten through graduate school in formal education, and in varied aspects of industrial, military, governmental, and adult education. The top priority of the Task Force for the next three years is generating promotional strategies, developmental models, innovative materials, and other prerequisites to success in simplifying, synthesizing and vitalizing educational curriculums in all fields and at all levels.

Procedure

The first major step will be to develop an operational, general systems paradigm or model for functionally unifying progressively more facets of the social and natural sciences and humanities, based on a meta-language which will provide a common orientation to all fields. As a means of developing and implementing curriculums which will be based on this general paradigm, the Task Force will encourage the development of a national -- ultimately an international -- network of institutes and centers for general systems education, each with its own emphasis or focal point.

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For further information, write Task Force Chairman, Jere W. Clark, Center for Interdisciplinary Creativity, Southern Connecticut State College, 501 Crescent Street, New Haven, Connecticut 06515. Phone: (203) 387-6661.

SYSTEMS: CONTEXT, THEORY AND CONCEPTS

In the next four days you will be exploring specific tools and techniques which have evolved in the systems domain. I believe you and our educational process can benefit by understanding and judiciously applying these techniques. But I'm deeply concerned about how, by whom, and to what ends these techniques are applied. I also have some biases that will become apparent as we proceed; biases which may cause you to think I'm anti-systems-approach. Perhaps I am at this point--in some respects.

What I want to do today is provide you a framework, a contextual map, to help you to begin the process of absorbing, understanding, and evaluating all that you hear and see and feel in your forthcoming exploration into the systems domain. It's an exciting domain--a young, brawling, but rigorous domain that desperately needs capable people and high quality work, particularly in the field of education. I hope you're turned on by the challenge of really trying to understand the systems approach and applying it in your respective fields in education.

First I'd like to identify three major movements that have been percolating in the systems domain over the past 25 years. One is a military aerospace systems development process; another is general systems research; and the third is the popularization of systems concepts, techniques and jargon. Second, I'll try to characterize some of the viable concepts emerging from the first two movements and identify some of the major problems associated with the third. Finally, I'll highlight what I see happening as a result of these three movements, what some of the implications are, and the lessons learned.

CONTEXT: Three Movements in the Systems Domain

Of these three movements in the systems domain the military-aerospace systems development activity is the oldest, beginning about 1945, and commands by far the greatest human and economic resources. Serious research into general systems theory, the second domain, became organized about 1955 and has continues primarily as an interdisciplinary academically-oriented activity. The popularization and widespread diffusion of systems concepts began roughly five years ago.

Military-Aerospace System Development Process[1]

I want to devote some time to this first movement, the military-aerospace systems development process, because it is out of this context that many of the management tools have evolved that you're going to be hearing about. And I think it's important to recognize what the context was and what their particular needs and requirements were. The military aerospace systems development process had its origins in the second world war when scientific and quantitative methods began to be applied to the resolution of tactical problems and the improvement of existing weapon systems. The process began as operations research, analysis of operational tasks and experience to develop better operating procedures. The systems approach evolved from these efforts, fostered by the remarkably sudden growth in complexity and uncertainty in military decision making. This uncertainty stemmed from the technological revolution in weapons during and after W. W. II. The difficulty in making decisions grew as the complexity, sophistication, and scope of military weapons systems mushroomed.

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[1] Defense System Resources

The stressful consitions that helped create a need for the systems approach include: (1) little experience with new weapons, delivery systems and associated technology, particularly from the standpoint of getting widely dispersed and very d-fferent systems to work toward a common goal; (2) the difficulty of experimenting with and testing strategic weapons in a real environment. This forced system planners to begin to develop simulation techniques; (3) the technological complexity of weapons systems grew very rapidly; (4) managing the development, procurement, and maintenance of globe-spanning systems became more difficult; (5) heavy time pressures perceived because of extermal threats and internally generated fears.

Some of the factors that enabled us to achieve our present state of technological sophistication in military-aerospace systems were: (1) the hierarchical nature of the military establishment--a tight, almost dictatorial organization. With this kind of single-customer, high-level control, the military was able to make long-term program commitments. (2) A strong national commitment of our nation's resources to military superiority, with roughly one-half of our federal budget spent on military activities. (3) The tangible, physical nature of most military systems and their environment; that is, they were dealing with fairly quantifiable functions and performance requirements that obeyed relatively well-known laws of physics.

At this point, I would like to ask each of you a question and have you mull it over. How do these five stressful conditions and three factors that influenced the military aerospace systems development process compare with the situation presently facing education? Are there any similarities? Are there any differences? How do the two contexts differ, or how are they similar?

Now, what is the culmination of this 25-year process? We have achieved some fantastic technological feats and also superlative organizational achievements that have culminated in literally reaching the moon. But remember the essentially physical nature of the media and the conditions under which these results were achieved.

Yet, perhaps more important than the physical hardware results of the military aerospace systems development process are two other aspects: (1) the infrastructure that enabled these results to be achieved and (2) the present state of the system development infrastructure capability.

By infrastructure I mean the people, the organizations, the technology the major firms and the tiers of subcontractors and suppliers underneath them, the computerized information systems, the research institutes, the "think" tanks--in short, the massive military-industrial complex itself. Does education have a similar infrastructure, and what are the similarities and differences in the economic context within which these two infrastructures operate? Kenneth Boulding suggests that education operates essentially in a "grants economy" rather than an exchange economy with money for education being granted by many sources, public and private.[2] The military aerospace activity operates on almost a fiat economy run by a high-level, single customer. What does this imply?

State-of-the System Development Process

The systems development process refers to the kinds of activities and interactions which typically occur over time when applying the systems approach to conceive, developm and implement an aerospace system. If the system is large, complex and costly, such as the Polaris system or the supersonic transport, the process spans many years and it is difficult to characterize in a simple illustration; but by looking at three dimensions of this process, the essential relationships may be s-en if while you're doing this you can visualize all three dimensions superimposed and interacting.

Horizontal Dimension

The horizontal dimension characterizes the activities which occur over time during the development of an aerospace system. Figure 2 attempts to illustrate the process by identifying major phases, their sequence, and their typical duration relative to the total system cycle. The process begins with some combination of strategic policy analysis or broad conceptual studies that identify a need, requirement, or general problem. This activity is usually performed within the Department of Defense or by one of the "think" tanks (e.g. RAND, RAC, IDA) and is an ongoing activity. It typically results in a request for proposal (RFP) to have one or more defense contractors formulate and define the concepts in more detail. From this point on the process is performed largely by defense firms, although this whole development process involves both the customer and the military contractor in a continuing interaction.

Figure 2 identifies six more or less distinct activities which are performed sequentially: concept definition studies; operational systems design and analysis; system engineering and development; production, test, and installation; and finally, system operation and maintenance. The seventh activity, program management spans the last five and is performed jointly by some combination of defense firms, the specialized contractors, and project or program officers in the military customer agency.

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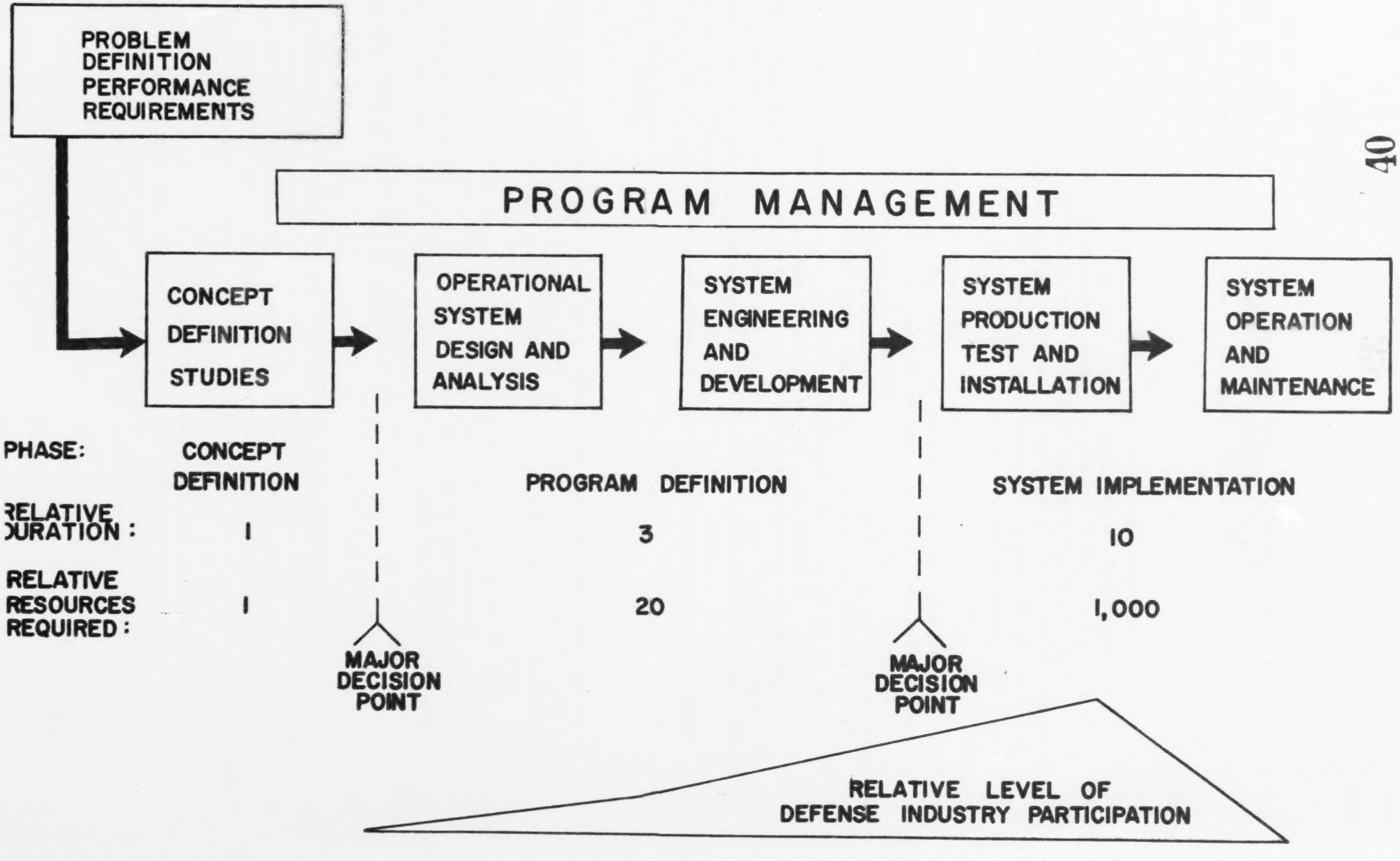
[2] Kenneth Boulding, "The Economics and Financing of Technology in Education: Some Observations," Planning for Effective Utilization of Technology in Education, Designing Education for the Future: An Eight-State Project. 1968, pp. 367-372.

FIG. 2 SYSTEM DEVELOPMENT PROCESS


PROBLEM DEFINITION PERFORMANCE REQUIREMENTS
PROGRAM MANAGEMENT
CONCEPT DEFINITION STUDIES
OPERATIONAL SYSTEM DESIGN AND ANALYSIS
SYSTEM ENGINEERING AND DEVELOPMENT
SYSTEM PRODUCTION TEST AND INSTALLATION
SYSTEM OPERATION AND MAINTENANCE
PHASE:
CONCEPT DEFINITION
PROGRAM DEFINITION
SYSTEM IMPLEMENTATION
RELATIVE DURATION :
1
3
10
RELATIVE RESOURCES REQUIRED :
1
20
1,000
MAJOR DECISION POINT
MAJOR DECISION POINT
RELATIVE LEVEL OF DEFENSE INDUSTRY PARTICIPATION

In recent years on of the lessons that the military has learned is that this program management activity should be conducted in large part by the customer. Prior to this they had left most of this to the defense industry contractor.

The linear sequence of activities in Figure 2 is misleading in that it fails to show the iterative nature of the process. Even the conceptual system analyst is concerned with operational questions: What will be the real operating environment? How will the system be maintained--by whom, with what tools and skills? The realization by the military that the operation and maintenance of a complex system could cost more in dollars and problems than the initial system purchase cost contributed much to the development of the systems approach. For the approach demands that throughout the design and development process one pay attention to how well the total system in its operating environment will meet clearly defined goals. Thus, while this process looks linear, it is really a circular kind of activity continually repeating through progressively more detailed cycles.

The defense system development process, as it has evolved, now consists roughly of the three phases shown in Figure 2: concept definition; program definition; and system implementation. This process might span five to ten years in a typical system development process with the first phase taking roughly one unit of time, the second three units, and the third ten units. In terms of the resources used--the men, materials and money required--it is roughly on the order of one unit for the first phase, twenty for the second, and perhaps a thousand for the third. At the end of each phase there is a major decision point. The concept definition studies, for example, have defined the concept in some detail, they've given the customer an idea of whether it is feasible to develop the system, and if so, what it might look like, what are some alternatives, how much each might cost. At this point the customer has to decide whether to continue. If so, he sends out additional requests for further developmental work. Typically, the concept definition studies are done by anywhere from two to four contractors working in parallel. They are not necessarily working together; in fact, they are usually competing. The military typically takes the best of this effort, pulls it together, and develops a much more refined concept and then sends that out for bid for further development. So again the emphasis here is on the fact that it is a continuing interactional process.

The tools and techniques you'll hear about in the next few days are largely an outgrowth of what has happened in the program management activity, plus the policy analysis activity which kicks off the process in Figure 1. PERT (Program Evaluation Review Technique) is a program management technique that helps in identifying and scheduling detailed activities within a system, while PPBS (Program Planning and Budgeting Systems) which evolved at high levels of program management within the Bureau of the Budget, within RAND, and within high levels of DOD, is more concerned with overall policy analysis, the setting of objectives, and the comparison of budgeting activities.

Vertical Dimension

Another dimension of the system development process is the vertical interaction of customer and contractors, and among the many systems under development with basic research, as illustrated in Figure 3. This illustration shows only the major kinds of interactions, not the enormous variety that exists. It also helps to characterize one portion of the infrastructure mentioned earlier. At the top is the defense customer who is involved primarily in the concept analysis, major decisions, and in the overall management process. The defense customer includes the three services--the army, navy, and air force--and the "think" tanks which typically are very closely tied with DOD. The second band represents the many systems under simultaneous development by a variety of contractors with each system going through the process illustrated in Figure 2. Below the major defense contractors are a host of large and small subcontractors, many of whom are primarily commercial firms. Finally, the fourth activity involves basic research and development that includes the universities, the "think" tanks, the defense firms themselves with their R and D activity, plus many commercial firms. The activity represented in the two lower bands, the R and D plus the first and second tier subcontractors, does not generally involve systems work. That is, the people performing these activities need not be systems people. Rather they are specialized scientistsor producers of goods and services performing specific and discrete functions. Yet these specific non-system activities and the money to pay for them are an outgrowth of the system development process and the management of these "non-system" activities is part of the system manager's job. Thus most of the people with systems skills are found in the upper two bands: within DOD, the "think"tanks, and the major aerospace firms, although this is actually becoming less and less true as systems people diffuse into all levels and organizations in the society.

Hierarchical Dimension

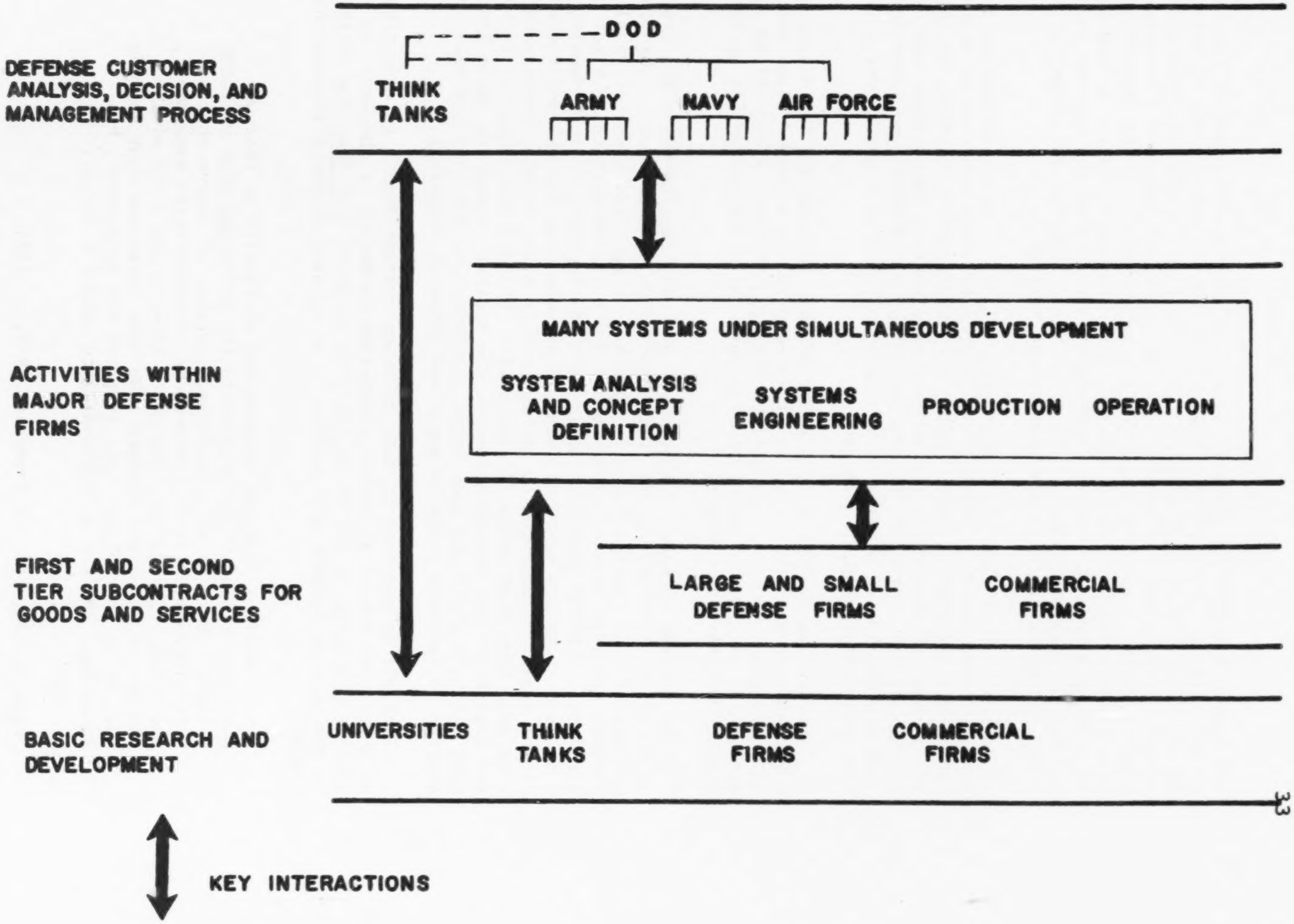
The fact that there is a hierarchicy of overlapping and interacting systems is obvious, but because is is so obvious it is sometimes ignored. Unfortunately, there are no commonly used descriptors which indicate whether an individual or an organization possesses system capabilities at a macro level or a micro level or somewhere in between. I think it is important to ask yourself at what hierarchical level in the education domain your interests lie. The broader and longer the term, your concern, I think the more important will be the PPBS concepts and what's going on in general systems research which I'll get into later. The more here and now oriented your concern, the more useful may be some of the specific management tools and techniques such as PERT.

The three dimensional slices of the systems development process--horizontally over time, the vertical relationships, and the hierarchical differences--hopefully have given you a sensitivity to the complex and varied nature of the military aerospace systems development process. It's important to note this is a very dynamic process: it's continually changing, continually evolving new forms, new techniques, new tools.

Scale of System Development Process

To give you a feel for the scale of the systems efforts which aerospace firms are accustomed to, I'd like to show three charts which were contained in a report by the Lockheed Corporation in a study they did for the State of California. Back in 1964, Lockheed was given a small

FIG. 3 SYSTEM DEVELOPMENT PROCESS--VERTICAL INTERACTIONS


DOD
DEFENSE CUSTOMER ANALYSIS, DECISION, AND MANAGEMENT PROCESS
THINK TANKS
ARMY
NAVY
AIR FORCE
ACTIVITIES WITHIN MAJOR DEFENSE FIRMS
MANY SYSTEMS UNDER SIMULTANEOUS DEVELOPMENT
SYSTEM ANALYSIS AND CONCEPT DEFINITION
SYSTEMS ENGINEERING
PRODUCTION
OPERATION
FIRST AND SECOND TIER SUBCONTRACTS FOR GOODS AND SERVICES
LARGE AND SMALL DEFENSE FIRMS
COMMERCIAL FIRMS
BASIC RESEARCH AND DEVELOPMENT
UNIVERSITIES
THINK TANKS
DEFENSE FIRMS
COMMERCIAL FIRMS
KEY INTERACTIONS

six-month, $100,000 contract to study the information needs of the State of California. These graphs, taken from their final report, illustrate the kind of program that Lockheed felt the State needed to develop a statewide federated information system. Lockheed proposed a hundred million dollar, ten-year development program just to cover the development stage. Figure 4 shows manpower distribution by year. At the peak it reaches almost 300 people, with heavy emphasis on the systems and operations analyst category. It gives you a feel for the scope, the size, and the distribution of talent and manpower.

Another chart from this same study (Figure 5) shows cumulative program cost by years, while a third chart (Figure 6) shows the cost by years and category. Aerospace systems people are accustomed to thinking in terms of long-range, often complex and usually very costly, large-scale systems. California has initiated the development of a statewide federated information system, but at a much lower expenditure and at a much lower rate than was recommended by Lockheed.

Another way to look at the scale of this process and the extent of national resources committed to it is compare R & D expenditures for military goods vs. civilian goods. American industry spends "7.50 for every $100 of civilian manufacturing out, while DOD spends $54 on every $100 of military procurement.[3]

The systems management techniques you will hear about in the next few days have evolved throughout this twenty-five year process, within the context of a military-industrial complex, by specific kinds of people, to meet specific technological needs, and to solve particular kinds of problems. I think you can benefit from developments in this domain, but I believe there are major differences between that context and the educational realm. I urge you to be cautious in using people, techniques, and knowledge from that realm in your realm. Despite truly amazing technological and organizational accomplishments, the military aerospace realm has had many failures and faces many tough problems, and the total process has exacted an enormous price in human and physical resources.

That all is not rosy in this military systems domain is made clear in an article by Robert A. Frosch, Assistant Secretary of the Navy, in an article appearing in the September 1969 issue of IEEE Spectrum entitled "A New Look at Systems Engineering." He clearly states a concern that I have:

> "I believe that the fundamental difficulty is that we have all become so entranced with the technique that we think entirely in terms of procedures, systems, milestone charts, PERT diagrams, reliability systems, configuration management, maintainability groups, and other minor paper tools of the systems engineer and manager. We have forgotten that someone must be in control and must exercise his management, his knowledge, and his understanding to create a system. As

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[3] Science, Vol. 166, 28 November, 1969, p. 1124.

FIG. 4 MANPOWER – DISTRIBUTION BY YEARS

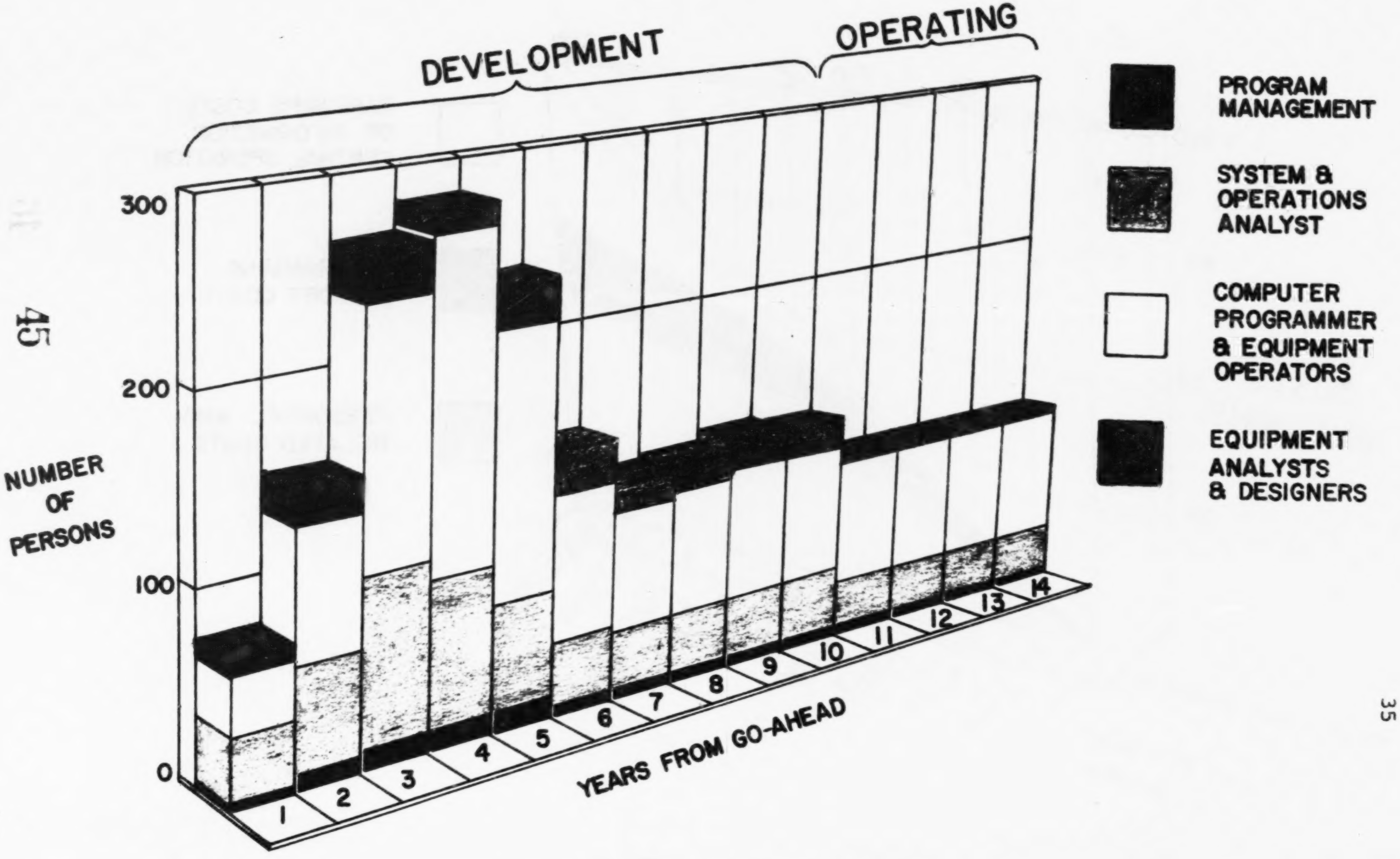


FIG. 5 CUMULATIVE PROGRAM COST BY YEARS (TOTAL DEVELOPMENT PROGRAM)

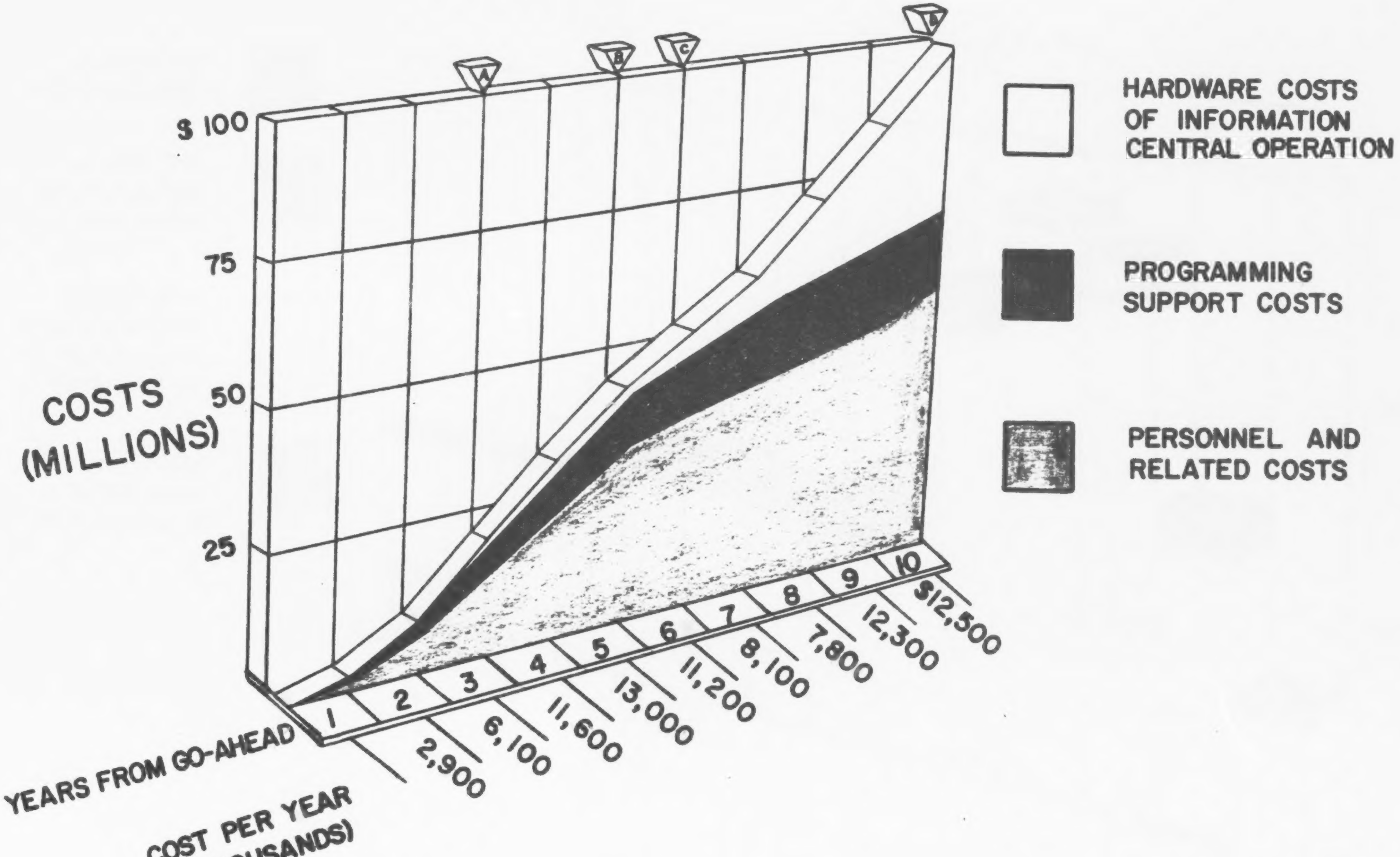
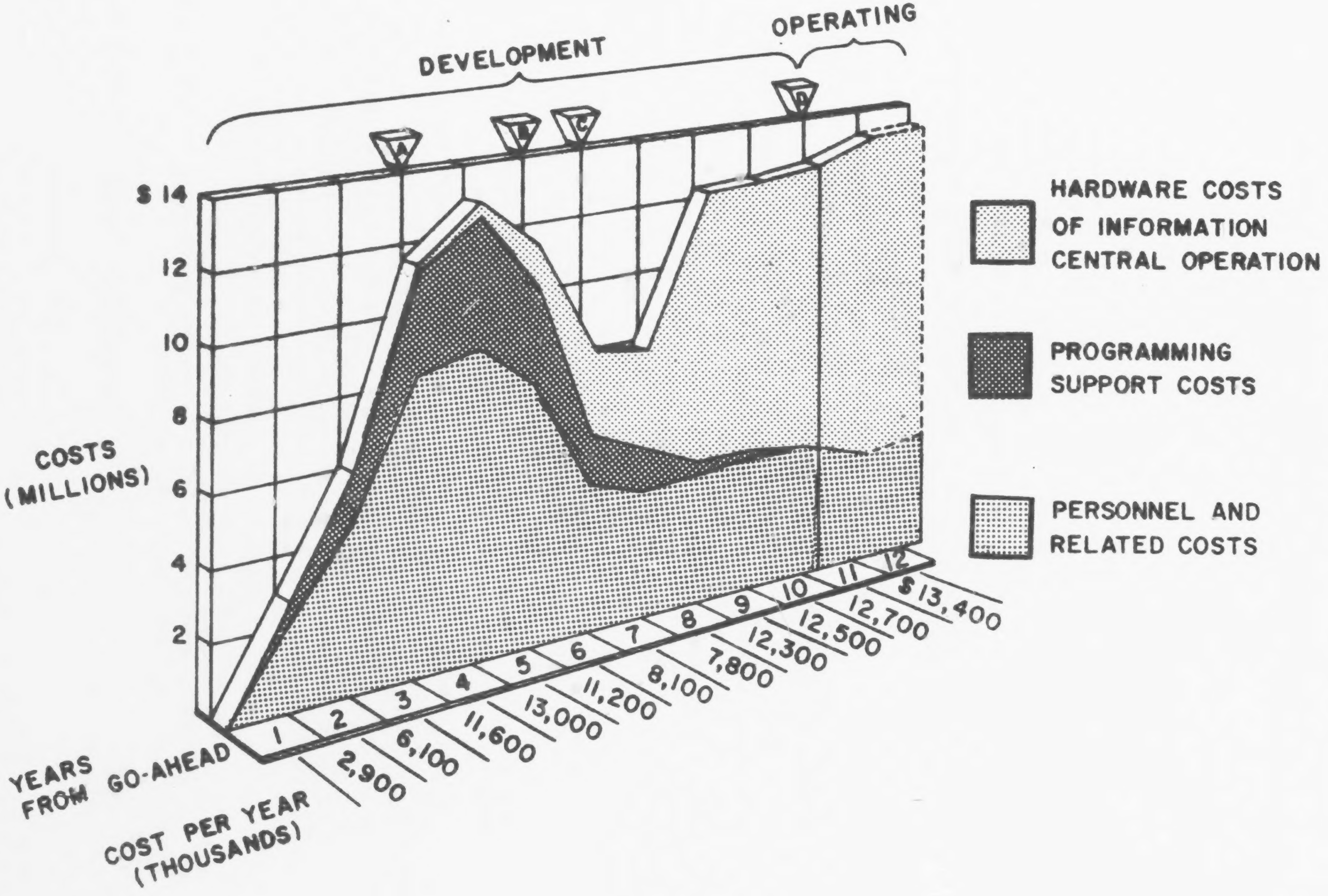


FIG. 6 COSTS BY YEARS AND CATEGORY



> a result we have developments that follow all the rules, but merely fail."[4]

Another quotation from Frosch highlights a second key problem area. He says:

> "One of the key mis-assumptions in modern systems engineering and systems analysis is that the total problem can, and frequently is, decomposed into subproblems; the subproblems can be solved more or less independently, and the total solution can be synthesized by a combination of the subsolutions, treating their interactions of the parts as 'interfaces.' The real world is, however, highly nonlinear, and unless real attention is paid to this fact, the linear decomposition treatment will fail catastrophically, because the interaction terms may be as large as the subproblems and not reducible to simple interfacts. The result may well remain decomposed."[4]

What Frosch is advocating here is the need for a more holistic approach, and this is a major theme for those involved in general systems research.

General Systems Research

This second major movement in the systems domain, general systems research, has been under way since about 1955. Men line Bertalanffy, Rapoport, and Kenneth Boulding have been struggling to develop a theoretical framework applicable to all types of systems--a general systems theory that would apply in biology, mechanics, or sociology. They believe that there are laws, principles, and models which apply to generalized behavior systems irrespective of the particular goal of the system or the nature of its parts. General systems research delves into systems as wholes and how to deal with them--the general analysis of organization, the interrelations among parts, the interaction between a system and its environment, the nature of feedback of goal-seeking behavior, of self-direction, the mechanics of control, and the continual evolution of structure in complex, adaptive systems.

Norbert Wener's work in cybernetics plus the fundamental contributions of Shannon and others in Communication theory are vital parts of this movement, for the emergence of this second movement, in Walter Buckley's phraseology: "marks a transition from a concern for eternal substance and the dynamics of energy transformation to a focus on organization and its dynamics based on the triggering effects of information transmission."[5] In essence this movement has made us aware that the whole is something more than just the sum of its parts and that crucial to the whole is the organization of its parts and their dynamic interaction.

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[4] Robert A. Frosch, "A New Look at Systems Engineering," IEEE Spectrum, Vol. 6, No. 9, September, 1969, pp. 24-28.

[5] Walter Buckley, Sociology and Modern Systems Theory, Prentice-Hall, Englewood Cliffs, N. J., 1967.

I personally feel that education should become more familiar with the work in the general systems area for I think some of education's most fundamental problems have to do with its inability to function as an adaptive total system.

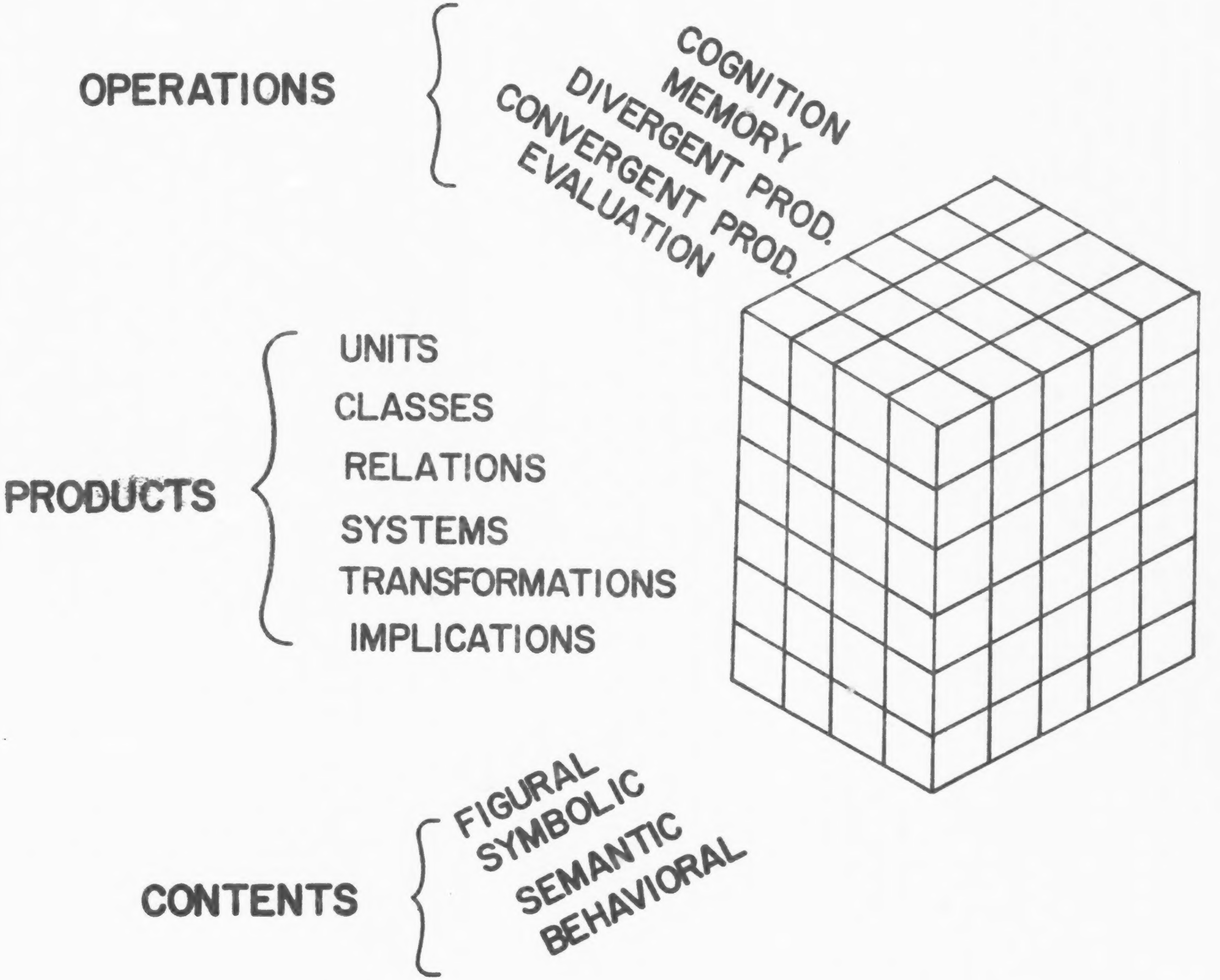
You have in your packet several papers, one by Ross Ashby, who's done a good deal of work in general systems area. Another is called "A Survey of General Systems Theory" by O. R. Young. This appeared in the 1964 yearbook of the Society for General Systems Research. Young's article is not a summary of principles and concepts, rather its value lies in that it helps to identify the kinds of concepts being developed to describe, explain, and predict the behavior of a general system, and to identify some of the key people working in the field. It is an interesting survey in that it presents an author-concept matrix which relates each of the 39 authors covered to the relevant concepts (out of a total of 36) which each author has employed in his writings. His survey confirms the synthetic and interdisciplinary nature of general systems research, for the 39 authors he includes in his survey represent 11 different disciplines--biology, engineering, psychiatry, sociology, political science, mathematics, communications theory, economics, mathematical biology, psychology, and philosophy. But no educators.

I think it is important to note that within this broad interdisciplinary movement there are many different interest areas (in addition to discipline-related areas). One involves the search for general principles and theoretical models; the other interest area has to do with applying these principles to the real world. An illustration of the first interest area is a paper presented by Marny and Smith called "The Domain of Adaptive Systems: A Rudimentary Taxonomy." It appeared in the 1964 yearbook of the General Systems Research Society. It is an attempt to begin to understand and develop explanatory models of some hierarchical ways of classifying and organizing systems. I think this kind of approach is more of interest to the theoretical, academically-oriented person, although a quick run through of it can very often give you a new perspective on how you look at systems.

A more familiar illustration of the search for theoretical models might be Guilford's structure-of-the-intellect model. Guilford is trying to develop a model of man's intellect based on a three-dimensional matrix that has major operations on one axis, major products being dealt with on another, and the contents on a third asix, as shown in Figure 7. If it an effective theoretical model in either the explanatory or predictive sense, it can be a very powerful tool.

Another illustration of some of the work going on in general systems area is a paper from the 1962 yearbook of the Society for General Systems Research by Warren Bennis called "Toward a Truly Scientific Management: The Concept of Organizational Health." Essentially what Bennis is doing here is trying to develop criteria for measuring the effectiveness, the health, the vitality of an organization in terms of psychologically-oriented criteria rather than the more traditional efficienty-related criteria. The kinds of criteria Bennis proposes have to do with adaptability, developing self-identity, and reality-testing.

FIG. 7 STRUCTURE - OF - INTELLECT MODEL


OPERATIONS
COGNITION
MEMORY
DIVERGENT PROD.
CONVERGENT PROD.
EVALUATION
PRODUCTS
UNITS
CLASSES
RELATIONS
SYSTEMS
TRANSFORMATIONS
IMPLICATIONS
CONTENTS
FIGURAL
SYMBOLIC
SEMANTIC
BEHAVIORAL

What are the education functions you are involved with, what are the major goals associated with your activities, and what are the effectiveness criteria with which to measure goal attainment?

Another example of the kind of work going on the general systems area is a paper by Harold Cassidy entitled "The Univeristy Community System: Self-Regulated Bearer of Meaning,: which appeared in the 1966 yearbook of the Society for General Systems Research. His figures convey a rather holistic view of what a university is and what it is all about. First, he defines two subsets, sciences and humanities, as the relevant activities of people who gather together in departments of the university, as shown in Figure 8. He suggests this is one way to look at the university, and there see to be some useful patterns emerging from the model. The sciences on the right, clockwise from the very hard sciences into mathematics, which is in a sense a scientific language, a method of cummunicating, that is very close to logic and linguistics. Cassidy sees mathematics and history as bridging disciplines between the sciences and the humanities. Cassidy is suggesting that two disciplines which are close together have more connection or relationship than two which are opposite on his model. He is not trying to say anything is above or below anything else.

Amplifying on that is Cassidy's model, The Sphere of Knowledge and Experience, shown in Figure 9. Assume this is a sphere with the various subject disciplines that were on Figure 8 placed around the equator, the humanities on one side and sciences on the other. Cassidy suggests that the philosophies tend to be integrative, synthesizing sorts of activities that draw on all of the disciplines. The technologies at the bottom are also integrative, synthetic kinds of activties. They again draw on all disciplines to apply what is learned in a very practical sense. All of the disciplines actually go through the synthesis, data gathering, and application to practice, but there is a different emphasis depending on whether you are at the top or the bottom of the sphere and that around the circumference there tends to be a difference in emphasis in terms of whether they deal primarily with metaphor and analogy as they do in the humanities or whether they deal more in a measurable sense of using ratios, physical measurements.

Now one of the thoughts I had was could you take a model such as Cassidy's here and combine it in some way with Gilford's concept of the structure of the intellect and develop a very different way of looking at what goes on in the university, perhaps in 3-D, like Will Burton's walk through living cells models for the medical profession. In other words, if an incoming student is interest in imporving his ability for divergent thinking or convergent or whatever mosaid of intellectual activities he is most interested in, can you somehow direct him thorugh a program that focuses on those intellectual activities rather than focuses on disciplines as such? Essentially behind Cassidy's model is the notion that there really are no divisions between subjects. There shouldn't be any departmental organizations. It's one operation, one kind of process going on. But unfortunately to talk about them and to deal with the elements you have to describe them as if they are separate subjects.

FIG. 8 SCIENCES AND HUMANITIES DEFINED

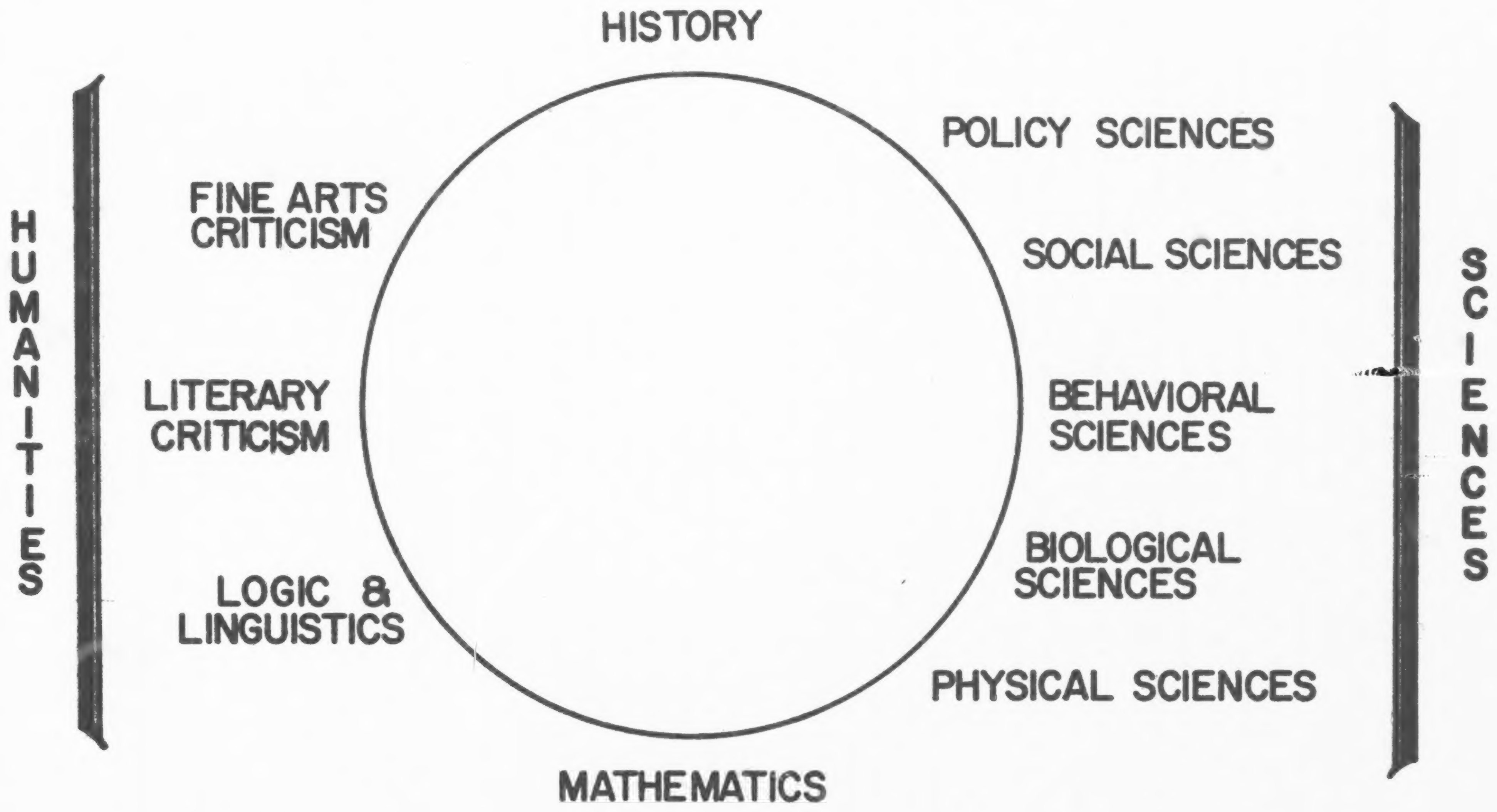
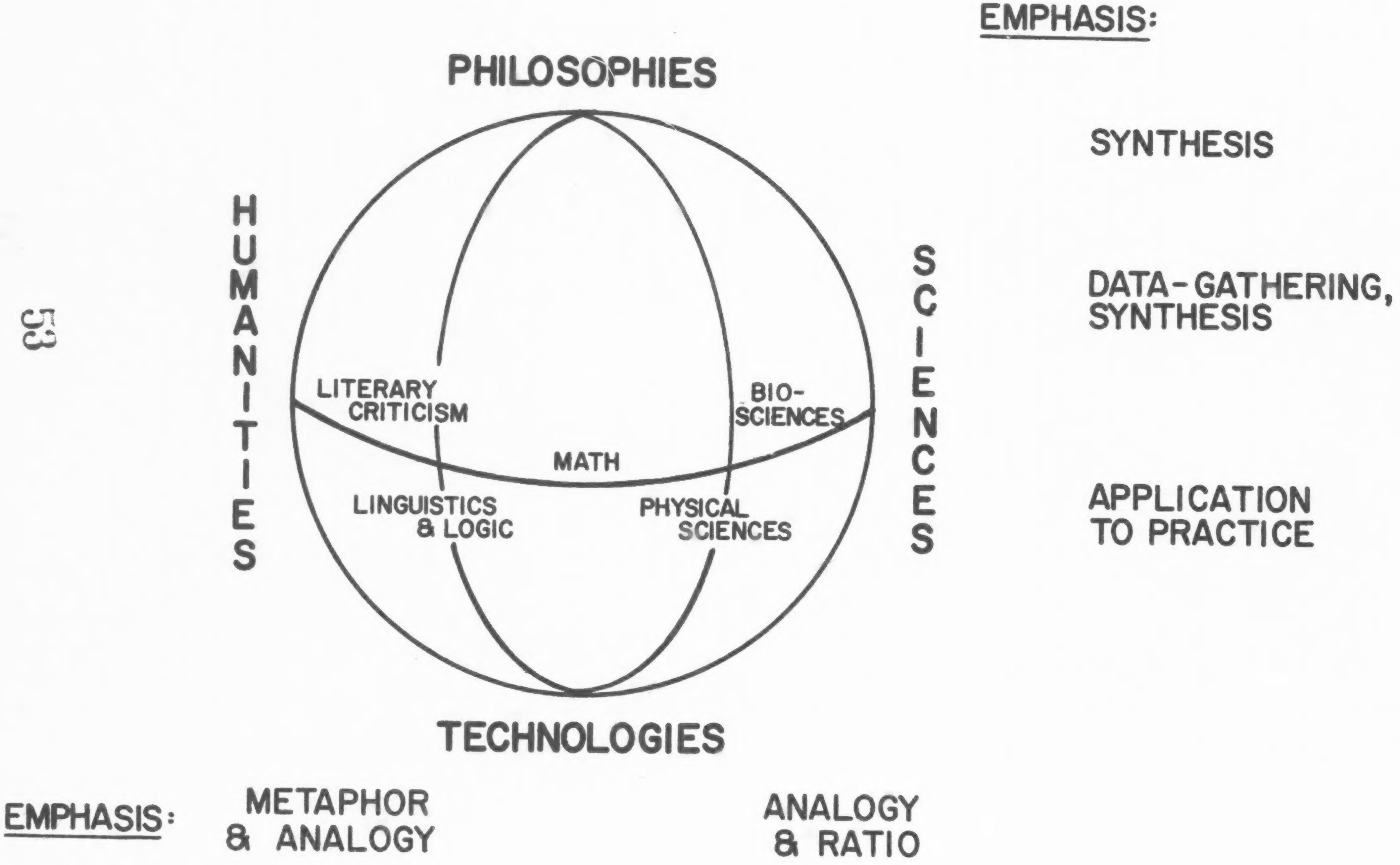

HISTORY
POLICY SCIENCES
SOCIAL SCIENCES
BEHAVIORAL SCIENCES
BIOLOGICAL SCIENCES
PHYSICAL SCIENCES
MATHEMATICS
LOGIC & LINGUISTICS
LITERARY CRITICISM
FINE ARTS CRITICISM
HUMANITIES
SCIENCES

FIG. 9 THE SPHERE OF KNOWLEDGE & EXPERIENCE


EMPHASIS:
PHILOSOPHIES
SYNTHESIS
HUMANITIES
SCIENCES
DATA-GATHERING, SYNTHESIS
LITERARY CRITICISM
BIO-SCIENCES
MATH
LINGUISTICS & LOGIC
PHYSICAL SCIENCES
APPLICATION TO PRACTICE
TECHNOLOGIES
EMPHASIS:
METAPHOR & ANALOGY
ANALOGY & RATIO

I've tried to give you a brief flavor, and it is just a flavor, of what's going on in general systems research. The paper you have in your handout by W. Ross Ashby is a more in depth introduction to this domain. It is a very different kind of a movement than the military aerospace systems development process, and later on I'll try to get into some of the specific concepts that have emerged from general systems research.

Popularization of Systems Concepts

The third domain I call the popularization of system concepts. I really don't think I need to dwell on it. I think you're familiar with its emergence in the last five years and probably in part because of it you decided that it was important to come to this training session. I have a feeling that many of you feel uneasy about where education is going, and you look toward the newly emergent systems expert as the Moses who will lead you out of bondage into the promised land. I hope to dissuade you of that. Mose of you have probably been bombarded and hopefully already disillusioned by the claims of the teaching machine merchants who bandy the jargon of systems and sophisticated technology. You've run into computer experts and software specialists who plied you with hardware and programs that promised to resolve the scheduling problem or simplify your administrative responsibilities. And I think in many cases in a very narrow sense they can simplify and help your operations, but in a more fundamental sense they can make it much more difficult. I hope we can get into that a little later too.

Much of this popularization has really benefited education, but I'm concerned about the emphasis. I'm afraid there is too much focus on technique and not enough attention paid to fundamental problems that must be resolved before the techniques can be of real use in furthering education's goals. Unfortunately, many of these superficial techniques tend to make your organization less able to change.

Systems Theory and Concepts

Now let me go on to the second major section--system theory and concepts. The organization and content of this section draws heavily on Walter Buckley's very excellent synthesis in his book Sociology and Modern Systems Theory. Buckley feels that modern systems theory, though a seeming offspring of the postwar era, is the culmination of a broad 200-year shift in scientific perspective from concern for inherent substance, qualities and properties, to a central focus on principles of organization per se. The physiologist, de la Mettrie, in 1747 was one of the first to propose a resolution of the age-old dilemma: if man is composed of essentially the same mechanical, insensible raw material as brute animals and even inanimate earth, whence man's consciousness, his thinking and feeling? de la Mettrie suggested: "Matter was in itself neither organic nor inorganic, neither living nor dead, neither sensible nor insensible. The difference between these states or properties of material things sprang, not from the intrinsic natures of their raw materials, but from the different ways in which these materials were organized."

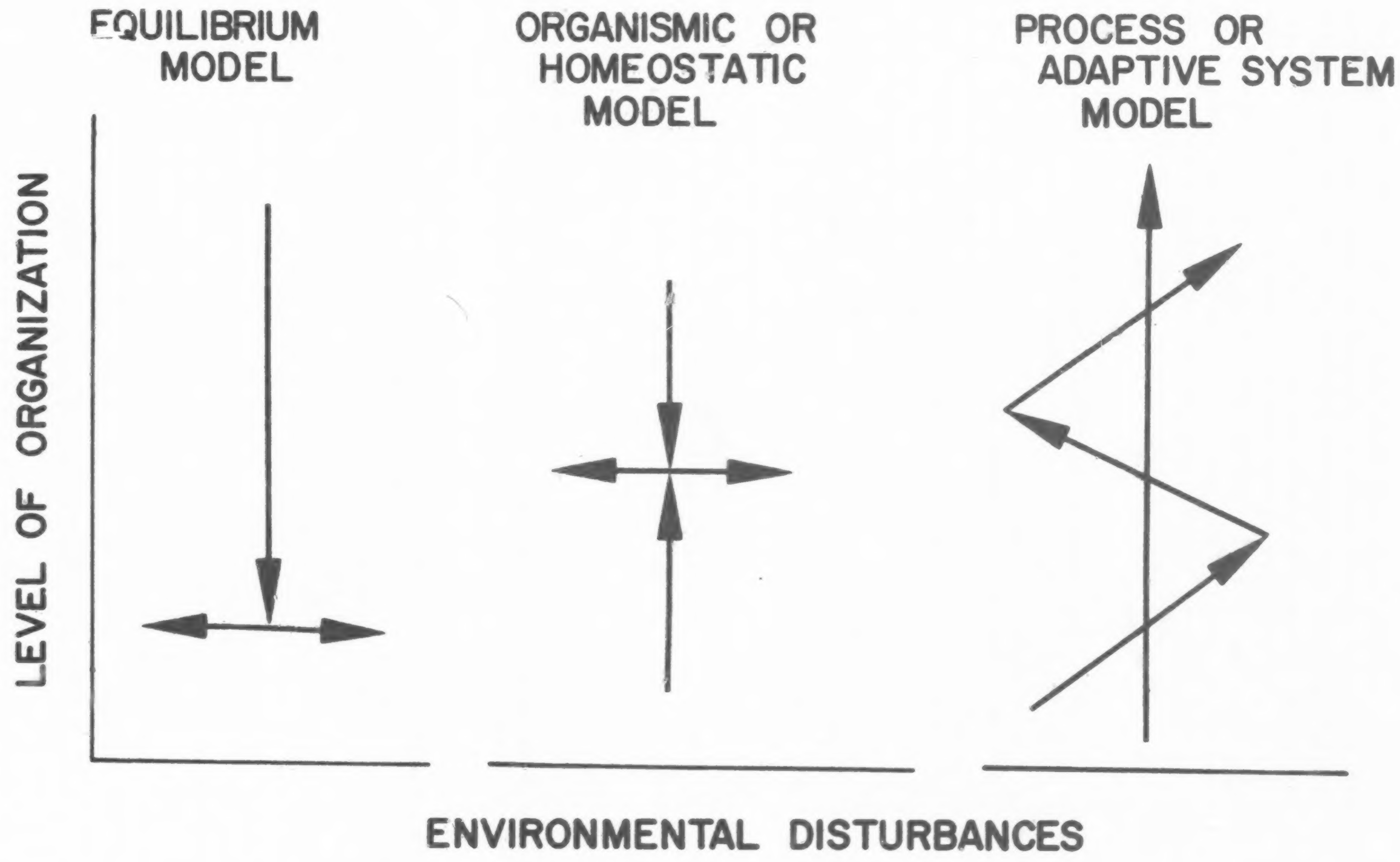
More recently men like Whitehead have recognized that the growing problems or organized complexity could not be adequately treated by the classical physics approach. The required approach lay rather in the organic holism of biology whose procedures emphasize more strongly than physics, (1) the teleological or causative explanation, and (2) classification and categorization. Modern systems theory, through cybernetics, has applied physical laws and principles in the construction of networks or causal relations, including closed-loop feedbacks to give respectability to the teleological approach; and through typology, the taxonomic branch of mathematics which is qualitative rather than quantitative, has enabled description of complex behavior systems. These two conceptual tools, cybernetics and typology, along with decision theory, are at the foundation of that branch of science which deals with organized complexity; that is, organization theory. The modern systems approach aims to replace the older, analytic, atomic Laplacian technique with a more holistic orientation to the problem of complex organization. In the view of W. Ross Ashby, the centuries-old strategy of varying one factor is now of use only when the system is fairly simple. The way not to approach a complex system, Ashby says, ". . . is by analysis, for this process gives us only a vast number of separate parts or items of information, the results of whose interactions no one can predict. If we take such a system to pieces, we find we cannot reassemble it."

CONCEPT 1: Types of Systems

Figure 10 identifies three fundamental kinds of systems characterized by Buckley: (1) mechanical or equilibrium systems, (2) organismic or homeostatic systems, and (3) process or adaptive or socio-cultural systems. The vertical axis represents level or organization. One extreme implies complete disorder, chaos, things not working together, while in the upper extreme, things would be functioning in a very coordinated, tightly controlled, organized manner. The horizontal axis represents environmental disturbances outside the system, remembering that every system is embedded within a larger environment. The equilibrium model tends to exist at a fairly low-level of organization. It can operate only within fairly narrow limits of environmental disturbance and it tends to decrease in level or organization over time, i.e., it tends to decay, to decompose, to go into disarray. A mechanical clock is an example of an equilibrium system. It tends to achieve a certain equilibrium level of operation. If it's wound, it will continue to operate, but only within very narrow limits, and without the proper environmental disturbance (winding) it stops--its equilibrium point.

The third general type of system Buckley calls process or adaptive systems. This type includes the self-directing kind of system that is typical of human organization, and is the one I think we're most interested in. Typically, this kind of system depends on the interaction with the environment. It is continually changing; it is continually increasing its level of organization. Man is the anti-entropic force in nature if you consider entropy as the tendency for natural and manmade systems to decay and decompose. Man tends to provide a force in the opposite direction by organizing things in a way so that more and more complex structure is evolved.

FIG. 10 TYPES OF SYSTEMS


EQUILIBRIUM MODEL
ORGANISMIC OR HOMEOSTATIC MODEL
PROCESS OR ADAPTIVE SYSTEM MODEL
LEVEL OF ORGANIZATION
ENVIRONMENTAL DISTURBANCES

The adaptive type system depends on disturbances and variety in the environment. There is continual change in the nature of the system itself and also a continual evoluation of more and more complex forms of systems. The evolution from microbes through fish, plants, animals, to man is one example of this adaptive process. Typically, a healthy organization will go through this process also. It starts small and is relatively flexible. As it grows, it develops more complex forms. But too often, as it grows, it loses its self-adaptive ability, and becomes tied to rigid and inflexible policies. This is an importnat way in which to assess your own organization: is it really operating as a process, or adaptive system model that is continually growing, expanding, and developing higher levels of organization, or is it stuck in a rut?

CONCEPT 2: Simple to Complex

The nature of the parts or components in these three kinds of systems tend to be very different. In a mechanical system the parts are typically relatively simple in their own structure. They are stable and not appreciably or permanently affected by being part of the system. By contrast, as we proceed up through the organic and socio-cultural levels, the components within these systems tend to become much more complex in their own organization, more and more unstable or susceptible to change by small forces, and more fundamentally alterable by the workings of the system of which they are a part.

CONCEPT 3: Systemic Relations: Energy Links to Information Links

The nature of the relations among components varies importantly for different types of systems. Interrelations tend to be simple, narrowly restricted, and with few degrees of freedom in mechanical systems where the structure is rigid. The relation among components in the equilibrium model tends to be a function of space and time and the transmission of physical energy from one part to another with these energy exchanges following well-understood quanitfiable laws. In the organic and socio-cultural systems, the relations of parts become more flexible with more degrees of freedom and the structure more fluid. Furthermore, the relationships depend more and more on the transmission of information rather than energy. There is still a transfer of energy, but the energy carrier is less important than the information. This is a very fundamental point and must be clearly understood. If two of us stand facing each other and I push you, you're going to move. This physical interaction exemplifies the mechanical model. I've set you off balance and you lose your equilibrium, you fall down. If instead, I ask you a question and say "what is your name?", you understand, you get the message, you respond by answering the question. But you get something much more than just the acoustic energy falling on your ear. If I instead spoke in Hindi, and said "Ap ka nam kia hai?", I dare say you would not get the message even though the acoustic energy is the same, and the question is the same, but now the understanding is not there.

So, there is a very fundamental difference in the way systems operate when in one case they rely more on phusical energy interactions compared to the siutation where they rely on information transfer. Thus information is not a substance or a concrete entity, but rather a relationship between sender and receiver who have a common mapping of structure, in this case the English language. Information in this sense can be a tremendous amplifier of energy, disobeying all laws of physics. In a real sense information then can represent structure or organization and thus preserve it, transmit it over space and time, and change it. The evolution of levels leading up to the socio-cultural system show greater and greater dependence on indirect, arbitrary or symbolic communication linkage of components and less and less on substantive and energy linkages until at the socio-cultural level the system is linked almost entirely by conventionalized information exchange with process overshadowing any rigid substantial structure such as is found at organismic level.

To relate this concept to what your direct interests are, I think many of our present notions of efficiency, of measuring performance, of designing and organizing systems or departments are based on the tradition of dealing in physical concepts, in energy transfer. Industry, and too often education, tend to measure performance by the number of goods produced, the cost per man hour, the overall efficiency of what it is doing. The socio-cultural type system demands different kinds of evaluative criteria than the mechanical type system which relies on energy transfer, the socio-cultural system needs the kind of information-oriented criteria typified by Bennis earlier in this paper.

CONCEPT 4: From Closed to Open Systems

As one moves from the equilibrium mechanical system model to the adaptive, information processing socio-cultural model, the system tends to shift from a closed one to an open one. Essentially what this refers to is the nature and extent of the system's interaction with the environment. The closed system tends to operate independent of the environment--up to a point--after which an environmental intrusion will cause it to "run down," to exhibit entropy or increasing disorder. For the open system, interaction with the environment is an essential factor underlying the system's viability, its reproductive ability or continuity, and its ability to change. Thus, open systems are anti-entropic, tending to elaborate structure and create higher organizational forms. This is why they are called adaptive.

CONCEPT 5: Feedback and Purposive Systems

Probably the most important distinction between physical, equilibrium-seeking systems and the higher order, anti-entropic, information processing, adaptive systems has to do with the latter's purposive or goal-directed behavior embodied in the concept of feedback. Popularization of system concepts has led to misues of the term "feedback." It does not mean simply response to an action or communication, or simply reciprocal interaction between variables. As a principal underlying the goal-seeking behavior of complex systems, Buckley feels it is something much more. As he states it: ". . . it applies particularly to an open system: 91) whose characteristic features depend on certain internal parameters or criterion variables remaining within certain limits; (2) whose organization has developed a selective sensitivity or mapped relationship to environmental things or events of relevance to these criterion variables; (3) whose sensory apparatus is able to distinguish any deviations of the system's internal state and/or overt behavior from goal states defined in terms of the criterion variables;

and (4) such that feedback of this mismatch information into the system's behavior-directing centers reduces, in the case of negative feedback, or increases, in the case of positive feedback, the deviation of the system from its goal states or criterion limits."

The simple thermostat meets these basic requirements. It is a system of components open to one aspect of the environment, its temperature, and contains : (1) a criterion variable representing the particular temperature setting selected; (2) an element sensitive to the temperature of the surrounding air, such that; (3) the system responds to deviations of the air temperature on either side of the setting, by; (4) turning on or off the heating components, such that deviation is reduced (hence an example of negative feedback).

Feedback control systems are referred to as goal-directed, and not merely goal-oriented since it is the deviations from the goal state itself that direct the behavior of the system, rather than some predetermined internal mechanism that aims blindly. For effective self-direction, a socio-cultural system must continue to receive a full flow of three kinds of information: (1) information of the outside world, (2) information from the past with a wide range of recall and recombination, and (3) information about itself and its own parts.

I've tried to briefly discuss some of the fundamental concepts emerging from general systems research that I think are relevant to education, and I urge you to explore this whole area in more detail. One avenue I would suggest is Buckley's book Sociology and Modern Systems Theory. Another different but useful source is the June 1969 issue of Educational Technology. Bela Banathy's book, Instructional Systems, should be of interest to any of you in the curriculum development area. In the first couple chapters Banathy gives a brief but useful overview of system concepts. Another highly readable source is a book by C. W. Churchman called The Systems Approach.

To briefly summarize some key points: (1) Beware of entrancement with techniques. Use the system management techniques where they are appropriate, but not as ends in themselves. Recognize their limitations as techniques, and never forget the larger context. (2) System management techniques evolving from the military aerospace domain can help you better manage existing systems and organizations, but they may also be dysfunctional if you use them to institutionalize a bad system or entrench even a good program that is thereby prevented from changing, growing, and becoming a self-adaptive kind of system. (3) Be judicious in selecting systems people; find out their particular bag and biases, and their hierarchical level of operating the systems. (4) PPBS or PPBES, as Schellenberger calls it, if done well will force you to clarify goals and to identify criteria and devise mechanisms for measuring goal attainment. (5) And this is my personal bias, strive for improvement rather than optimization. (6) Evolutionary change is preferable to sudden introduction of a new system. (7) Remember that education is a complex, adaptive system whose viability depends on change and on its ability to create higher level structure and interaction. (8) Two integral parts of the rational, rigorous scientific approach embodied in the systems concept, I think, must be a willingness to explore and the inspired creativity to propose and test new forms, such as Boulding's voucher concept or George Leonard's scenario of the Kennedy School in his book Education and Ecstasy. Just because this approach tends to rational, in a sense systematic, doesn't mean that there is no creativity in it. (9) Finally, let me quote from C. W. Churchman in the conclusion of his paperback The Systems Approach, he is a professor at Berkeley, rather knowledgeable in the systems area, I think. This is what he winds up with, and it may seem rather puzzling. He says: "I arrive at the conclusion that however a systems problem is solved--by planner, scientist, politician, anti-planner, or whomever--the solution is wrong, even dangerously wrong. There is bound to be deception in any approach to the system. And yet when one looks at the solution and sees its wrongness, one is also deceived because in searching for the wrongness, one misses the progressive aspect of the solution."

"What is in the nature of systems is continuing perception and deception, a continuing reviewing of the workd, of the whole system, and of its components. The essence of the systems approach, therefore, is confusion as well as enlightenment. The two are inseparable aspects of human living. Finally, then, here are some principles of a deception-perception approach to systems: (1) The systems approach begins when first you see the world through the eyes of another. (2) The systems approach goes on to discovering that every world view is terribly restricted. (3) There are no experts in the systems approach. The real expert is still Everyman, stupid, humorous, serious, and comprehensive all at the same time. The public always knows more than any of the 'experts', be they economists, behavioral scientists, or whoever; the problem of the systems approach is to learn what everybody knows. And finally, my bias, (4) the systems approach is not a bad idea."

MANAGEMENT INFORMATION SYSTEMS IN EDUCATION

Fred K. Bellott

Many of the problems which will be considered during your week here are a direct product of the complex, technologically-oriented, affluent society in which we live today. The management function becomes increasingly complex as the society in which it operates becomes complex. One of the more significant management problems, but one which is not unique to management, is that of communication. Even if we could disregard the tremendous increase in knowledge during our present generation, if we could disregard the proliferation of printed materials, if we could disregard the interaction of societal and organizational components, we would still have major communication problems. To avoid some potential breakdowns in our communications, I would like to establish some operational definitions.

Definitions

Because of the diverse organizations which each of us represent, because of our varied backgrounds and our unique frame of reference, terms and phrases that are commonplace in today's jargon quite often have widely differing meanings to each of us. The phrase "management information system" perhaps illustrates this susceptibility to varied meanings as well as any. There are other phrases that are associated with or interpreted in similar ways, such as integrated information system, total information system, automated information system and articulated information system.

For the purpose of today's consideration a simple yet widely acknowledged definition of management is "the allocation of resources to the accomplishment of predetermined objectives." To carry out the management function information is needed at all levels of management for the purposes of planning, directing, coordinating, controlling, and evaluating the processes and/or products of the organization.

In defining the word, "information," I would like to contrast it with the word, "data," because we oftentimes use the two words interchangeably. The word data refers to collected statistics or other facts, usually expressed symbolically. They can be used as a basis for inference and/or conclusion. By contrast, information is knowledge--meaningful, valuable, timely knowledge of and about facts. The raw data that goes into an information system produces information by being processed. Data have only limited use until they are processed resulting in information for the user.

The "management information system" which is our topic today has as its purpose the production of information upon which management decisions can be made.

The word, "system," bothers many people. I would like to resort to a classical definition of system as "---an arrangement or combination, as parts or elements, in a whole, especially such an arrangement according to some principle; a group or assemblage of objects united by some regular form of interaction or interdependence." In reflecting upon this definition of the word, system, there is a readily discernible reference to a hierarchy. A system can be microscopic, or enlarged and comprehensive. System parameters are directly established by the limits of the organization to which they apply. We can refer to a state system of higher education, a metropolitan school system, a school's grading system, or a nation's governmental system. In any of these, the system is still a combination of parts or elements in a whole. The second part of that definition, "---a group or assemblage of objects united by some regular form of interaction or interdependence," has specific meaning when referring to a management information system. The interaction or interdependence of the parts is the base of reference in the term, "integrated information systems."

A management information system is a collection of smaller systems. In this context we sometimes refer to these smaller systems as sub-systems. We talk about, quite properly, a pupil information system, which is also a sub-system of the comprehensive information system. The pupil information system may even be a management information system, if it is used for management of pupil personnel, i.e., to make decisions in this area of management.

That part of the definition of system relating to a "combination of parts into a whole," while characteristic of a system, also has inferential meaning in relation to the term "total information system."

The phrase, "total information system," means different things to different people. To some it is simply a gross overstatement. To others it is a descriptive system parameter. Some who feel offended at the use of the word "total" in describing an information system, warn that this kind of description may lead management to actually expect a system that will produce everything. It's failure to do this will prove to be an embarrassment for systems personnel, because the results will fall far short of the expectations.

Calhoun and Morrison defined the total information system as "---a linked network of raw facts and processed data, the collection of data, the development and flow of information, the manual and automated procedures that make the network operative, and the organization that coordinates and operates the network, all of which are designed to provide information needed to operate, control, evaluate and plan the university (sic) process."[1] They set forth two conditions that must be met if one is to achieve a workable information system.

1. The coordination of all administrative activities, coupled with a decision-making policy that takes into consideration the overall company or institution without regard for the barriers of organizational segments or departments.

2. The collection of all data needed for the operation and management of the organization, at the points where the data originates, in a manner that will avoid duplication of collecting effort.[2]

If this definition and these conditions are acceptable as being descriptive of the "total information system," then one could also accept the terminology of a "comprehensive management information system" as referring to a "total information system."

Some writers make a very clear distinction between information for operational purposes, that is, routine functioning, and that for management purposes, for planning, evaluation, coordination, direction, and control. I am not sure that such a clear cut dichotomy exists in the educational community. Paul Henderson of United Aircraft Corporation Systems Center, provides a very useful description of an information system as "---the representation of some entity as data and the manipulation of the data in preference to the manipulation of physical objects."[3]

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[1] John C. Calhoun, Jr., and Don F. Morrison, A Report on Total Information Systems for Colleges and Universities. (n.p.) National Science Foundation (n.d.), p.3.

[2] Ibid. p. 3-4.

Whether or not any specific information area or data item is necessary for management is dependent on the nature of the organization and what management needs to know. In this respect there are perhaps some generalizable problem solutions in determining "what does management need to know."

Many times we get much more than we want. We become like the fifth grade youngster who asked "What is a penguin?" He was sent to the Encyclopedia Britanica. He expressed his findings this way, "If you want to know about penguins don't read the Encyclopedia Britanica. It tells you much more than you want to know."

Management information systems should not merely print out data when we need information. For management purposes you do not need raw data by the ream. What you do need is some meaningful information that is unobscured by the mass of surrounding statistics that may be useless and irrelevant. It is part of the job of the data processing operator and the programmer to validate and document data that is being used and the procedures utilized for processing, but it is completely inappropriate for management purposes for the manager to even read, let alone assimilate and use, these kinds of output.

Another problem that plagues us as managers is that we sometimes find that we cannot shut off the flow of information after there has ceased to be a need for it. A one-time request for information gets programmed into the system and it becomes a part of the standard operating procedure. Part of that same problem is receiving obsolete or out-of-date information merely because it has remained in the system.

Educational administrators, like other managers have to focus their attention on selectively determining what is the right information. He must choose between "nice-to-know" and "need-to-know" information. This choice is an individual requirement unique to the user and/or to his organization or institution.

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[3] Paul Henderson, "Management Sciences for Corporations," Management Information Systems. (Cleveland, Ohio: Association for Systems Management, 1969), p. 29.

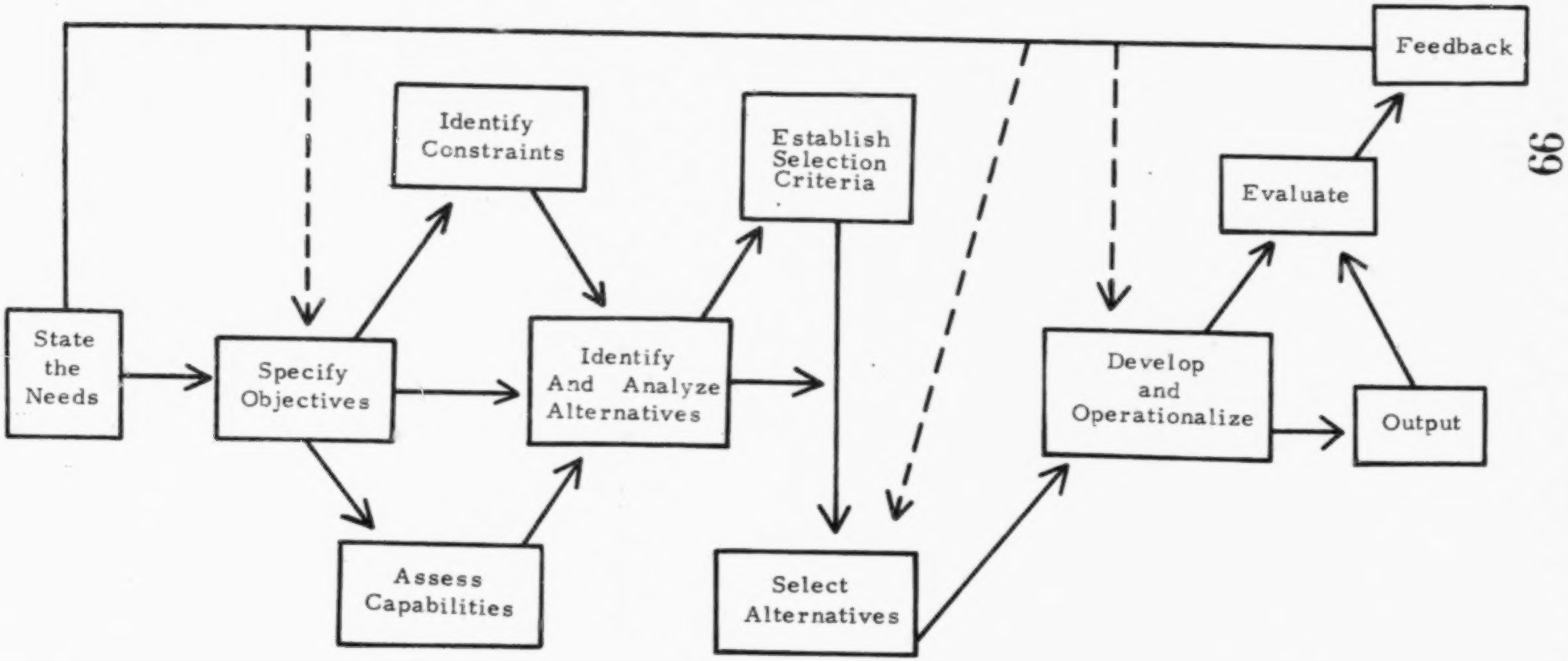
Assuming that the position he occupies and its related activities are clearly defined and understood, the information user can use a problem definition procedure to identify his specific needs for information. Through problem definition, one should identify the events, activities and entities that influence the program with which the problem is associated. Information about these are in the "need-to-know" category. By applying criteria tests to these problem elements he can make better informed decisions. In following through with a problem solution, the manager then needs information that will reveal to what extent were the objectives met. Problem definition leads to information specifications. When information output meets these specifications it should lead to problem solution---and this is the purpose of the management information system---to assist in the management process.

Systems Approach

Yesterday's topic of System's Theory Concepts was very ably presented by Drs. Hagerson and Gould and I would like to refer to these concepts in application to the management information systems subject. The systems approach diagram which I am using is a generalized one which serves here to identify its application to the effecting of a management information system. (See Figure 1.)

Figure 1.

SYSTEMS APPROACH DIAGRAM


State the Needs
Specify Objectives
Identify Constraints
Assess Capabilities
Identify And Analyze Alternatives
Establish Selection Criteria
Select Alternatives
Develop and Operationalize
Evaluate
Output
Feedback

STATE NEED:

Define the problem or the goal to be reached or the function to be performed:

A. Assist and enable effective management

B. Provide for the allocation of resources to their most appropriate task

C. Have readily available meaningful, timely information for decision-making

D. Fulfill other requirements for information, such as reports, input to applications subsystems, accounting, record-keeping, and various other operations needs

SPECIFY OBJECTIVES:

Define objectives in terms that permit analysis and measurement. Describe desired outcomes.

A. Establish criteria for basis on which judgment of success can be made

B. Provide data packages or subsystems that can be adjusted and integrated to provide for the basic program processes

C. Provide for special request information that may involve more than one file or one subsystem

D. Provide for exception reporting for management

CONSTRAINTS AND CAPABILITIES:

Identify existing and potential restrictions. Assess present and future resources.

A. Staff and the availability of additional staff

B. Physical facilities and equipment -- adequacy, possible modifications

C. Funding requirements -- cost/effectiveness relation-

D. Program

IDENTIFY ALTERNATIVES:

Consider all feasible ways of attaining objectives

A. Survey and analyze present systems (orientation/feasibility)

B. Manual versus automated system

C. Human resource utilization versus machine utilization

D. Applications conversions to management systems

E. Staged implementation (one subsystem at a time)

SELECT ALTERNATIVES:

Apply criteria (from stated objectives) to available alternatives to choose that one which will be implemented.

A. Cost/effectiveness basis

B. Performance/risk

C. Policy conformance

D. System Promises

Improved communications
Improved processing capabilities
Improved management information
Improved decision-making potential

OPERATIONALIZE:

Develop plans with details and implement on trial basis.

A. Staff assignment

B. Schedule, materials, facilities

C. Pilot test

OUTPUT:

The product should correspond with the objectives.

EVALUATE AND FEEDBACK:

Determine effectiveness in meeting objectives; modify as needed.

A. A continual process at all steps, as well as at the end of a cycle.

B. Feedback is necessary so that needed revisions are known.

I would like to refer again to Paul Henderson and his description of an information system as "---the representation of some entity as data and the manipulation of the data in preference to the manipulation of physical objects."[4] At first glance Henderson's description may appear to refer only to the simulation capabilities that are characteristic of an automated data processing insulation. More than this, however, Henderson is saying that it is much easier to use symbolic representations in our accounting, description and computation activities than it is to attempt to provide information by physically counting and juggling real people, dollars, materials, and equipment. Henderson has graphically displayed what he terms the functions of an information system that merits our consideration. One might choose some different labels to describe these functions, but this chart does tell a relatively complete story about what happens in and with an information system. (See Figure 2.)

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[4] Henderson, p. 29.

Figure 2

FUNCTIONS OF AN INFORMATION SYSTEM

DETECT EXISTENCE	ACQUIRE	ACQUIRE UNIQUENESS	DESCRIBE	TRANSFORM (ENCODE)	ACCUMULATE	MANIPULATE	TRANSFORM (DECODE)	PRESENT
ESTABLISH PRESENCE OF ENTITY NOMINALLY CONTEMPLATED BY THE SYSTEM	OBTAIN AND ACCEPT ENTITY INTO THE SYSTEM	DISTINGUISH ENTITY FROM ALL OTHERS	ESTABLISH CORRESPODENCE BETWEEN CHARACTERISTICS OF ENTITY AND CHARACTERISTICS SIGNIFICANT TO THE SYSTEM	CONVERT ENTITIES FROM ONE FORM TO ANOTHER TO FACILITATE SYSTEM PROCESSES	AMASS ENTITIES INTO A SET	CONDUCT PHYSICAL OR LOGICAL PROCESSES WHICH RECOVER ENTITIES OR CHARACTERISTICS	CONVERT ENTITIES FROM ONE FROM ANOTHER TO FACILITATE PRESENTATION	EXHIBIT OR DELIVER ENTITIES AS SYSTEM OUTPUT

Theory and Reality of Integrated Educational Information Systems

The advent of "third generation" computers, with their multiplexing capabilities and mass storage devices with randomized access, has been the focal point of efforts to create system designs which would facilitate the practical application of information-system-integration theories that have been espoused for several years. These efforts are beginning to bear fruit.

Progress toward full development and implementation of an operating information system with the potential of fulfilling the needs of educational management has been significant. Such automated data processing systems have been given a major boost by the involvement of educational practitioners who have worked together with data processing and research personnel. These joint efforts have resulted in pragmatically oriented systems that are both sound in data processing theory and administratively utilitarian.

The educational community has often been behind the times in "discovering" recently evolved technology that business and industry have already employed. The emerging role of data processing in educational administration and management is no exception to this slow evolutionary process. Educators are, however, learning more readily to adapt themselves, and their organizations, to the use of data processing as an administrative tool. It has been said that in education there is a time lag of a full generation between the acceptance of a new idea and putting it into practice. In the development and use of integrated information systems, at least, this time is being shortened considerably.

Spurred by the ever-increasing needs for information by educational administrators, by the impact of federal funds for research and development, by the interests of legislatures and state governmental agencies in better meeting their own needs, by the involvement of foundation support of innovative research to find realistic solutions to current problems, the educational community is taking a positive role in the development of educational information systems that can meet these needs. Some examples of the efforts which have been made are the following: (Figure 3)

Figure 3

MANAGEMENT INFORMATION SYSTEMS

PRESS	PUERTO RICO EDUCATIONAL STATISTICAL SYSTEM
MSEIP	MIDWESTERN STATES EDUCATIONAL INFORMATION PROJECT
OTIS	OREGON TOTAL INFORMATION SYSTEM
SPEDE	SYSTEM FOR PROCESSING EDUCATIONAL DATA ELECTRONICALLY
SIS	STUDENT INFORMATION SYSTEM

Chicago's "Total Information System"
"Oregon Total Information System" (OTIS)
"New England Educational Assessment Project" (NEEAPS)
"Midwestern States Educational Information Project" (MSEIP)
"Regional Educational Data Processing Centers in California"
"Iowa Educational Information Center" (IEIC)
Florida's "System for Processing Educational Data Electronically" (SPEDE)
Various projects from ESEA. Title III and the Regional Educational Laboratories

These programs and projects, as well as many others, similarly oriented, have at least one purpose in common--that of meeting an expressed need for educational information with maximal utility and minimal reporting and processing effort. These diverse efforts have all met with some success, (although it is inappropriate to make comparisons of them based on the degree of success which they have experienced).

Integrated information systems, educational or otherwise, are founded on the premise that data can be stored in structured machineable files, that these data can be accessed whenever needed; and, that these files can be inter-related through the use of common data elements.

Integrated educational information systems hold a real promise as an administrative tool to assist in the school management process. If the concept of integrated systems is to realize its potential among educational organizations, however, there are other related problems which must be resolved.

1. Use of common terminology and definitions of terms so that data from several sources have compatibility. Use of the data will not then be restricted to a limited segment of education or its publics.

2. Use of "basic" data (data reduced to one dimension) that can be applied to a variety of needs for the same or similar information.

3. Acceptance of the principals of "program-oriented budgeting and accounting" to permit relating financial data to other kinds of educational data and to specific educational activities and objectives.

4. Integration of data effected by utilization of common data elements among the several data files which permits associated identifications and relationships, thereby reducing repetition and easing the reporting task, as well as making possible a more effective use of information for management purposes.

5. Computerization of information systems in order to facilitate storing, processing and accessing large volumes of data by machine.

   Educational information systems, per se, are not new. They have been a part of the operation of educational organizations for a long time. Historically, the primary functions that have been served by these systems have been those of record keeping and reporting.

The traditional systems are often unduly constrained because they were organized to produce "operating information" rather than "management" information. These systems can readily produce payroll checks and report cards. They can make pro rata distributions of state funds to local school districts and produce annual statistical reports and still not meet the needs for management information with which important program decisions can be made.

Traditional systems have, in effect, often been fragmented collections of data that cannot be readily analyzed in terms of other data or other developments. They may, at times, almost defy attempts to synthesize meaningful program information for decision purposes, being overly weighted down by sheer logistics and lacking the capability of inter-relation.

The development of management information systems during the past decade has seen an ever increasing sophistication emerge in the technical applications being made and the imaginative uses of information being produced. We have only scratched the surface of what our present "know-how" gives us in potential use. However, the area of management information systems holds both promise and pitfall.

In recent years there has developed a current pressure syndrome that has effected society that is particularly related to the field of information and data processing. In the context of the field of data processing and information systems it is easy to comprehend why this syndrome has developed and continues to threaten logical approaches to problem solutions. *The heavy demand for the availability of new information and the technical answers, that are available through computerized systems, encourage everyone to sincerely desire answers immediately*.

Therefore, there is a tendency to over-sell and over-simplify the systems that are in the process of development that for the most part, are not yet fully developed nor fully understood. In spite of statements that you have heard and continue to hear regarding the simplicity of systems and packages that are available for immediate application, the fact is that they are not simple. They are extremely complex and will become more complex as time moves forward and the needs and opportunities for information increase in their complexity.

When something is over-sold and over-simplified, the result is that there is a tendency for procurers in the field to over-buy and over-promise. This can only result in various degrees of failure. When people (especially administrators, managers, and supervisors) fail in keeping promises, the result can be resistance to all new ideas. This common result of the current pressure syndrome is the real tragedy and tends to encourage further over-selling and over-simplifying.[8]

Having said that, I would like to relate some of the things that hold promise and cite some management information systems that are experiencing some success. First, let's look at related problems to be dealt with on a broad basis if we are to find solutions that are generalizable.

Definitions of Terminology

The terminology and definition problem (number 1 above), has been dealt with, in part, through the State Educational Records and Reports Series publications.[9] These Handbooks, beginning with The Common Core (Handbook 1)[10], 1953, identified appropriate terminology with definitions and provided a structure for organizing educational terminology into five informational areas, each of which is the basis of a handbook.

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[8] James W. Colmey, "Conference Summary," *MSEIP CONFERENCE PROCEEDINGS, 1969*. Des Moines, Iowa, September, 1969.

[9] State Educational Records and Reports Series, Handbooks I through VI, U.S. Department of Health, Education and Welfare, Office of Education, Washington, D. C., 1953.

The acceptance of the handbooks by state local educational agencies has been of a varied degree and over a lengthy period of time. Handbook II, Financial Accounting for State and Local School Districts, 1957, has enjoyed more popularity than any of the others in the series, having been accepted either in *toto* or at least in principle, in all 54 states and territories during its first ten years. The paradox is that with the now evident need for a "program-oriented" financial structure, Handbook II is more outdated than any of the others. It is, therefore, being revised and work is currently underway toward that end. The revision is being made through contract with a private management consultant firm.

Handbooks III, IV, and V dealt with the areas of property accounting, staff accounting, and pupil accounting terminology and definitions, respectively. Curricular or instructional programs terminology is the subject of Handbook VI. This publication (Handbook VI)[11] is presently in "Fourth Draft" form which is still a tentative status. Development of Handbook VI is now in its sixth year. According to Dr. Dale Chismore, who has been working on Handbook VI since 1964, final publication is now expected in 1970.

These handbooks provide a base on which solutions to terminology definition can be formulated. The greatest obstacle to their successful adoption has been the ingrained inertia from which the educational establishments suffer. The natural resistance to change, the self-satisfactions with the status-quo, yet an impatience by educational administrators with the lack of fulfillment of the glowing promises of automated data processing, have all added to the inability of school administrators to clearly understand

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[10] The Common Core of State Educational Information. Compiled by Paul L. Reason, Emery M. Foster, and Robert F. Will. U.S. Department of Health, Education and Welfare, Office of Education, Washington, D.C. 1953.

[11] Standard Terminology for Curriculum and Instruction in Local and State School Systems. Compiled by John F. Putnam and W. Dale Chismore. U.S. Department of Health, Education and Welfare, Office of Education, Washington, D. C., 1969.

and empathize with the problem. If management information is to be made available to the administrator, he in turn must concede some of the autonomy of his position; that is, he must permit the system to service his needs by understanding the contexts within which systems can function and limitations which are imposed by the system. He must also be able to adequately describe and delimit his desired output in terms that are acceptable to the system. The system does not dictate to the manager, but it does demand that he define his needs and operate within prescribed parameters. It is at this point that data definitions become quite important in the establishment and operation of the integrated educational information systems for management purposes.

Focus on Finance

The assumption is made that a need exists for management information systems development to assist in administrative decision-making.

Much effort has been expended, many articles written, numerous conferences held, and untold hours spent in committee deliberation in recent years regarding the prospects of "total," "compatible," "articulated," "multi-purposed" educational information systems. There have also been a number of worthwhile projects directed toward more single-purposes objective areas of information such as pupil information (e.g., Iowa's Card-Pac and Florida's SPEDE). However, these have not resulted in meaningful comprehensive systems becoming operational nor have such systems been directed toward solutions to problems of local school districts on a broad basis.

Our traditional financial accounting records have been based on the needs of fiscal auditors rather than managers who must make program decisions. In many organizations and educational institutions the entire responsibility for information system development was resident in the financial accounting office.

A usual first application of a new data processing installation has been to financial accounting. Educational administrators with organizational responsibilities have frequently abdicated the management role in determining how data processing technology is to be applied and toward what ends it would be directed.

Dr. Bill Curtis will spend Thursday with you describing PPBES and the related efforts of ASBO Research Corporation and the development of a program-oriented system to apply to financial data. (Figure 4) Suffice it now for me to allude to this development as the potential for fulfilling a real need we have for financial information about educational programs. The Planning, Programming, Budgeting and Evaluation System being developed holds the promise of making a major contribution as a vehicle for management information system development in the educational community. (Figure 5)

It is suggested that emphasis in management information systems development should be put on budgetary analysis, diagnosis and planning -- for two reasons: (1) Budgeting concerns represent real problems with which school administrators are forced to deal at all times. (2) This emphasis can serve as the catalyst needed to bring about a more meaningful comprehensive management information system and provide the starting point, the lack of which seems to stymie many otherwise good intentions in development.

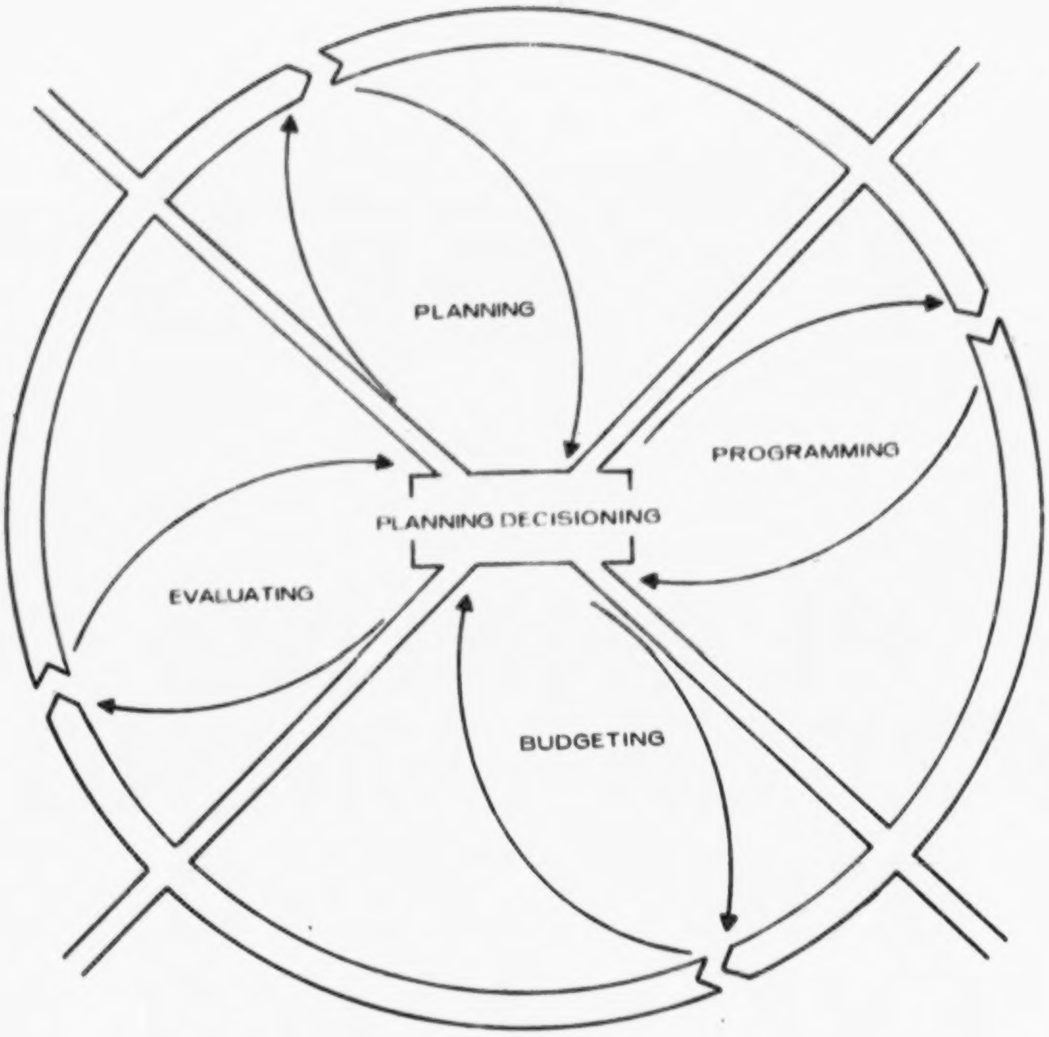
Program-oriented budgeting and accounting should enable school administrators and other decision-makers in education to obtain and use specific cost-benefit related information about educational programs. Educational decision-makers need to know what relationships exist between attainment of an instructional program objective and the costs of accomplishing that objective, as well as what the alternatives might be.

Basic Data

Several years ago an effort was made by the U. S. Office of Education to promote the concept of reporting educational information in "basic data" units. Known as the B.E.D.S. (Basic Educational Data System), it was never fully accepted as being realistic, although it was accepted in theory. The concept for B.E.D.S. was that, if all educational information were reported in its smallest unit or singular dimensional form, it was much more useful because it could be applied to a number of different contexts and uses.

Instead of adopting this concept of basic data units as a reporting base, we are still reporting summary information.

Figure 4



ERMD
Assumptions —

The financial resources available to the school system are less than equal the demands of the system.

The school system exists to produce a set of products -- to achieve certain objectives expressed as specific changes in characteristics of learners.

Objectives of a school system can theoretically be achieved in a multitude of ways (programs), some of which are more effective and/or efficient.

Productivity of a school system can be enhanced by organization of activities and services into programs specifically directed toward achieving carefully defined goals.

Better decisions regarding program selection and operation result when the costs thereof are considered on a longterm (multi-year) basis.

Better decisions regarding program selection and operation result when production (output) is methodically related to objectives.

FIGURE 5

PPBES

PLANNING
PROGRAMMING
BUDGETING
EVALUATING
SYSTEM

We report the "number of teachers who . . ." instead of reporting each teacher and that teacher's characteristics. We report sums of units instead of units, thereby severely restricting the ability of the data collection agency to generate new information through analysis of basic units.

The integrated information system will require basic data as input if it is to approach the promise of providing information which it has the potential of supplying. The smaller the unit or base used as a reporting unit, the more potential the data have for being meaningful.

MSEIP

The Management Information System (MIS) is a management tool, and is used by all types of private industries and government agencies. Whether the system is maintained by a group of clerks annotating ledger books with quill pens, or by the use of the most modern computer hardware and software available, has no bearing on the title. It is still an MIS.

All businesses have an information system of some kind. The single fact that it may be automated does not make it a good system. Because of the extremely rapid advance in computer technology many organizations have allowed their information systems to be programmed on increasingly larger and faster computers, but have not changed the structure or philosophy of the system to take advantage of the advanced technical capability. This is an MIS (Figure 6) that was allowed to remain static even though the investment in equipment to process the information may have increased many times.

The same agency, using the same equipment, after the thorough review and redesign of the organization and the system was made could reflect this type of system. (See Figure 7) The initial time lapse and the manpower effort would be of considerable scope but the overall results would, in the long run, be profitable because of the centralization of operations, the more immediate accessibility of the information and the capability to readily obtain more accurate and comprehensive information.

This (Figure 8) is an example of an Educational Agency that has allowed its information systems to grow as individual divisions or branches have dictated.

Figure 6

CORPORATE MANAGEMENT
INFORMATION SYSTEMS

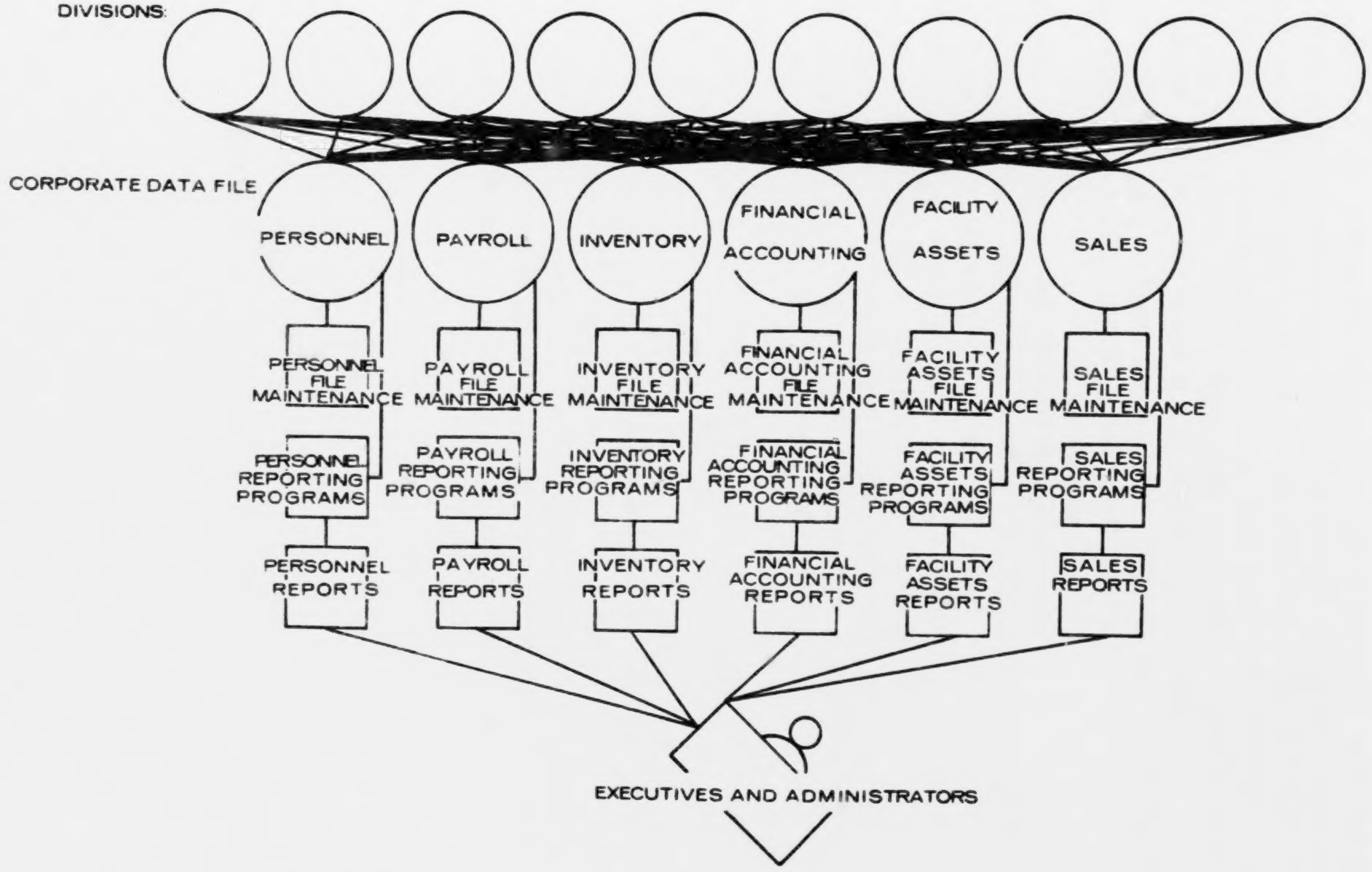

DIVISIONS
CORPORATE DATA FILE
PERSONNEL
PAYROLL
INVENTORY
FINANCIAL ACCOUNTING
FACILITY ASSETS
SALES
PERSONNEL FILE MAINTENANCE
PAYROLL FILE MAINTENANCE
INVENTORY FILE MAINTENANCE
FINANCIAL ACCOUNTING FILE MAINTENANCE
FACILITY ASSETS FILE MAINTENANCE
SALES FILE MAINTENANCE
PERSONNEL REPORTING PROGRAMS
PAYROLL REPORTING PROGRAMS
INVENTORY REPORTING PROGRAMS
FINANCIAL ACCOUNTING REPORTING PROGRAMS
FACILITY ASSETS REPORTING PROGRAMS
SALES REPORTING PROGRAMS
PERSONNEL REPORTS
PAYROLL REPORTS
INVENTORY REPORTS
FINANCIAL ACCOUNTING REPORTS
FACILITY ASSETS REPORTS
SALES REPORTS
EXECUTIVES AND ADMINISTRATORS

Figure 7

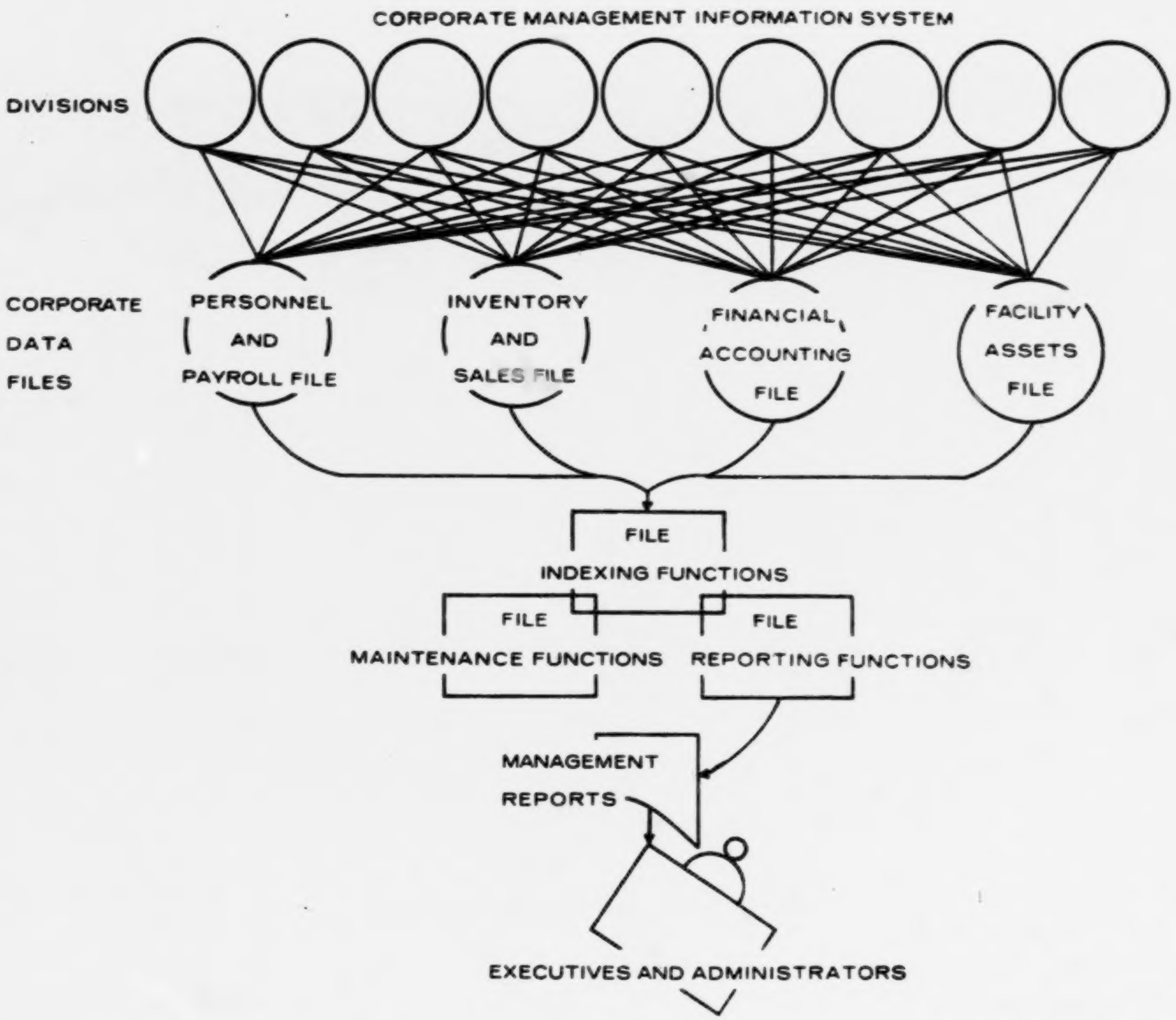
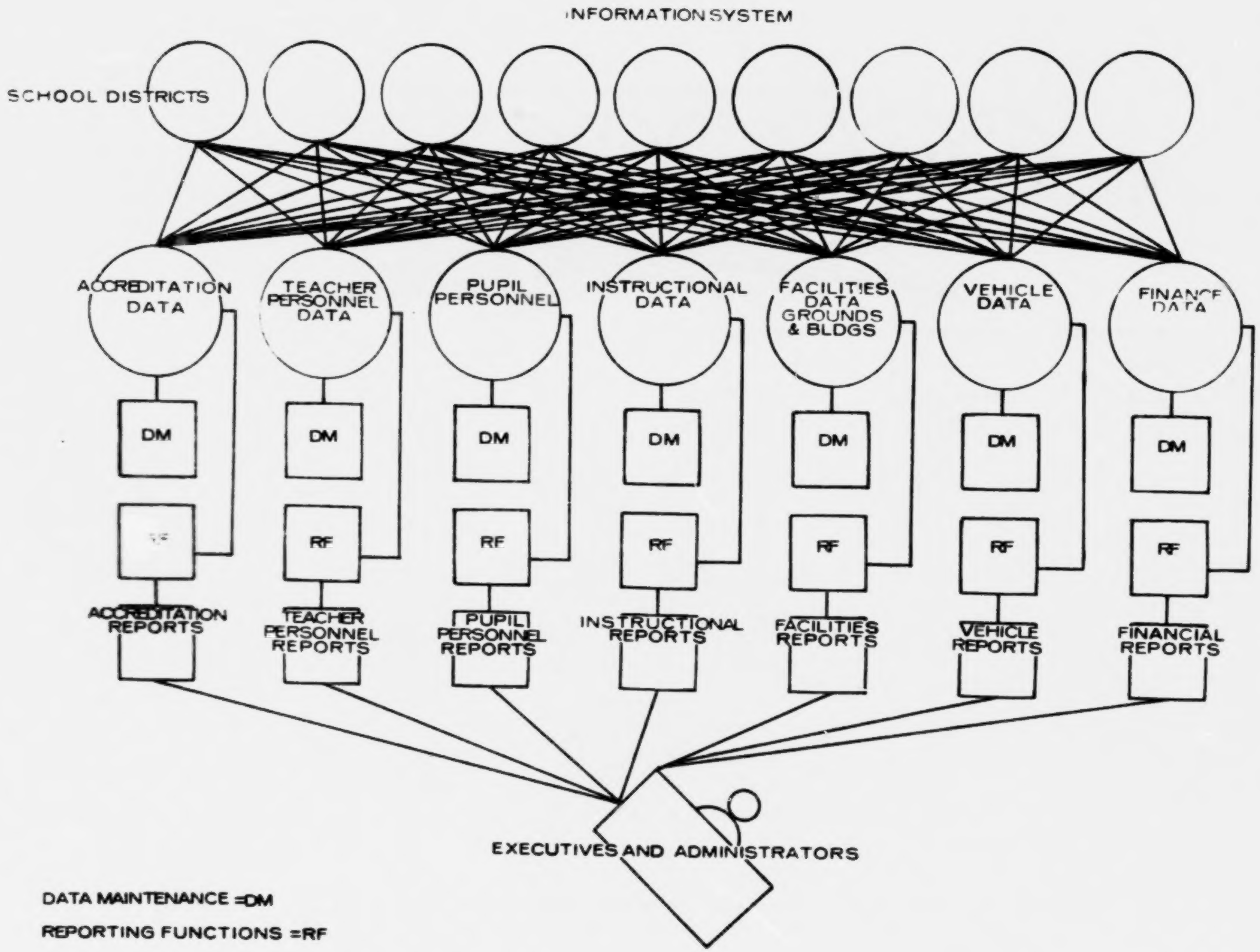

CORPORATE MANAGEMENT INFORMATION SYSTEM
DIVISIONS
CORPORATE DATA FILES
PERSONNEL AND PAYROLL FILE
INVENTORY AND SALES FILE
FINANCIAL ACCOUNTING FILE
FACILITY ASSETS FILE
FILE INDEXING FUNCTIONS
FILE MAINTENANCE FUNCTIONS
FILE REPORTING FUNCTIONS
MANAGEMENT REPORTS
EXECUTIVES AND ADMINISTRATORS

Figure 8


INFORMATION SYSTEM
SCHOOL DISTRICTS
ACCREDITATION DATA
TEACHER PERSONNEL DATA
PUPIL PERSONNEL
INSTRUCTIONAL DATA
FACILITIES DATA GROUNDS & BLDGS
VEHICLE DATA
FINANCE DATA
DM
RF
ACCREDITATION REPORTS
TEACHER PERSONNEL REPORTS
PUPIL PERSONNEL REPORTS
INSTRUCTIONAL REPORTS
FACILITIES REPORTS
VEHICLE REPORTS
FINANCIAL REPORTS
EXECUTIVES AND ADMINISTRATORS
DATA MAINTENANCE =DM
REPORTING FUNCTIONS =RF

The most significant deficiency of such a system is that without a centralized comprehensive system there is much redundancy and duplication of effort, and the individual who has need of specific management information quite frequently does not get it in readily usable form nor as promptly as he might require. By contract, the same agency using the same equipment, after thorough review and redesign of the organization and the system was made could reflect this (Figure 9) type of system. It will allow management level personnel to have more accurate information readily accessible, and organized in a manner to fit an efficiently structured management organization.

Integrated System Concept

The integrated management information system is a holistic concept that overcomes the fragmenting of traditional systems by treating all input data in terms of the effects each input has on all others. Files and subsystems in the integrated system are inter-related, yet can be treated either individually or collectively within the system. The interrelation of data or integration of files and data items is a "logical" dimension of the system. (Figure 10)

In the logical dimension, data items and definitions are related to functions of the system. Each file in the system, and its contents or data items, is supportive of the other files and their contents. Together the files collectively support integrated functions or those requiring data from several files. Common data elements must be included in the several files to serve as linkages or passageways to enable the system user to relate data from one file to another. An example of this is the teachers identification number which appears in the personnel file to identify the teacher assignments, and in the payroll (or finance) file to identify costs. This data element is used in the way just described by the Midwestern State Educational Information Project (MSEIP). Each file (Figure 11) provides for linkage or access by way of a data element that also appears in one (or more) of the other files.

Access to each file, through a common data element is accomplished through the use of the computer. The indices for the files are groups of identification data elements along with computer stored file addresses which determine where certain data are stored and how they can be accessed.

Figure 9

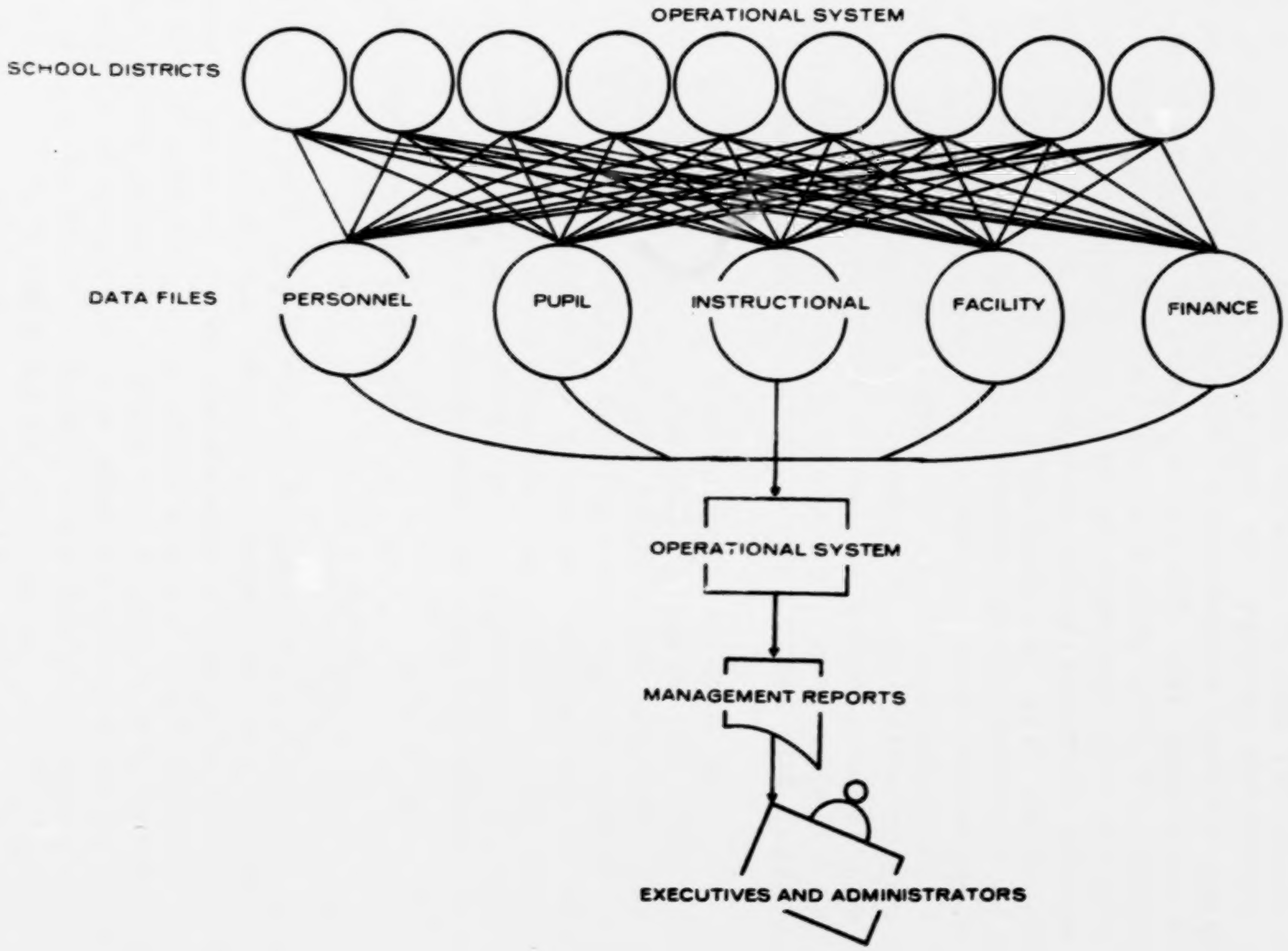

OPERATIONAL SYSTEM
SCHOOL DISTRICTS
DATA FILES
PERSONNEL
PUPIL
INSTRUCTIONAL
FACILITY
FINANCE
OPERATIONAL SYSTEM
MANAGEMENT REPORTS
EXECUTIVES AND ADMINISTRATORS

Figure 10

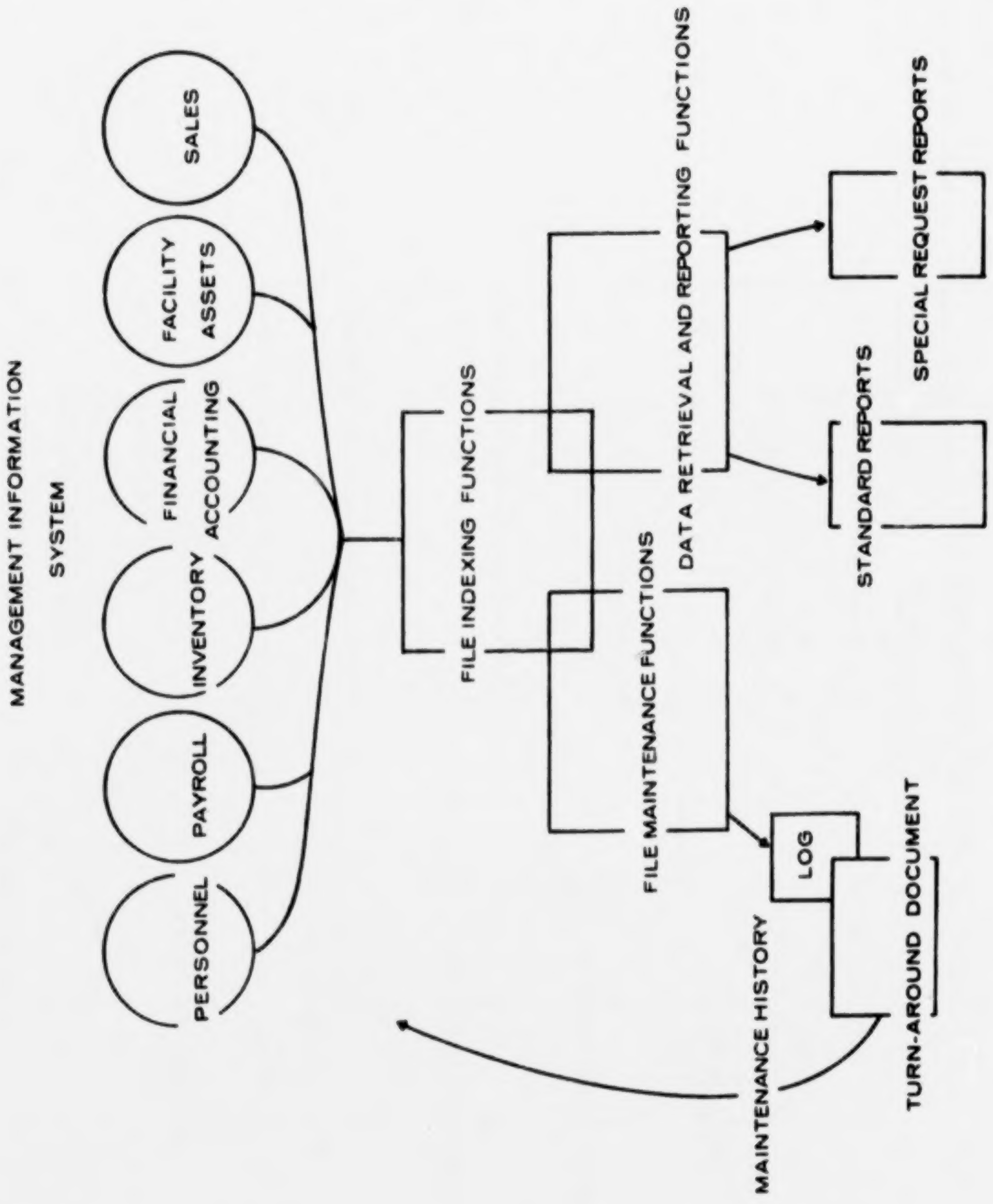
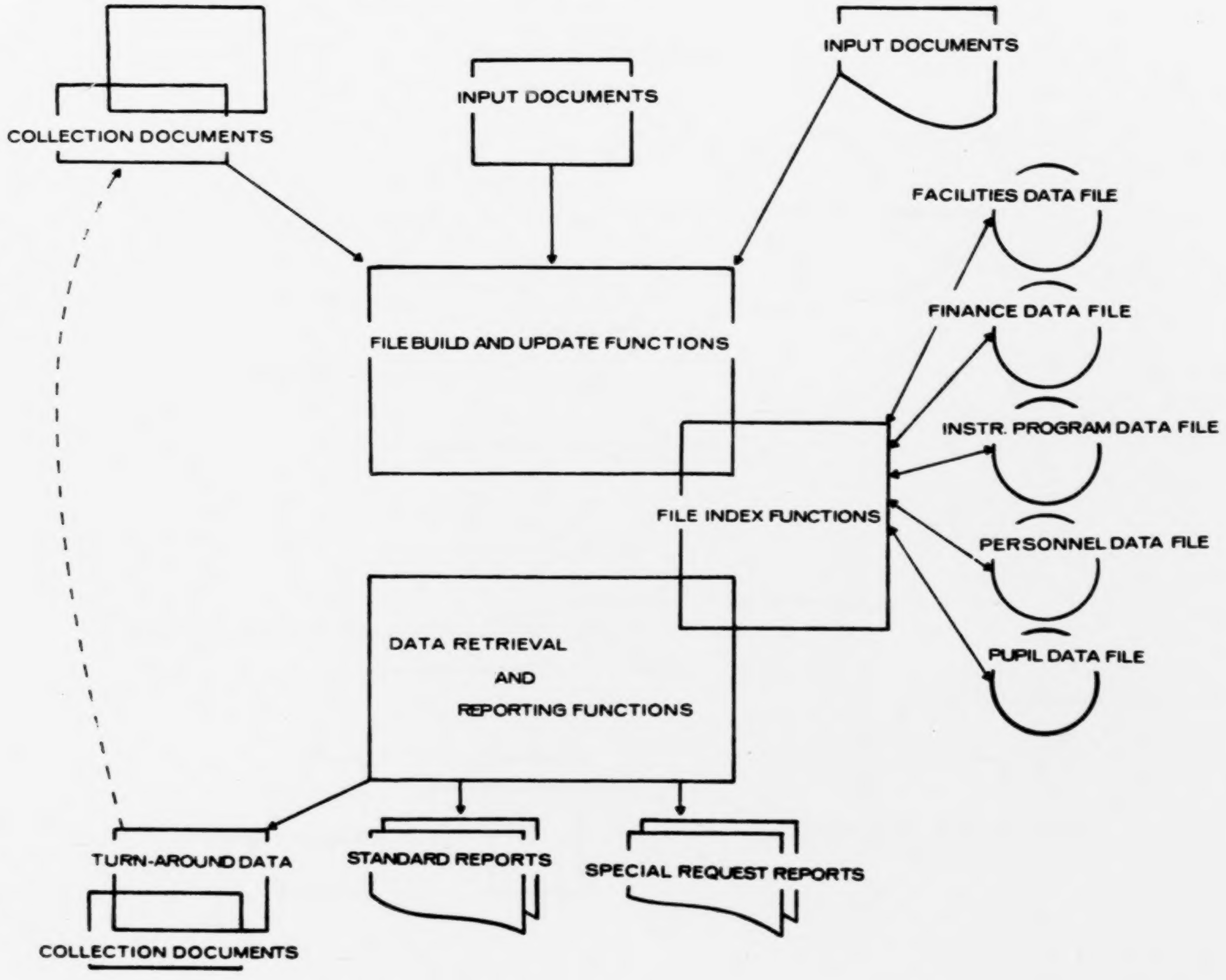

MANAGEMENT INFORMATION SYSTEM
PERSONNEL
PAYROLL
INVENTORY
FINANCIAL ACCOUNTING
FACILITY ASSETS
SALES
FILE INDEXING FUNCTIONS
FILE MAINTENANCE FUNCTIONS
DATA RETRIEVAL AND REPORTING FUNCTIONS
LOG
MAINTENANCE HISTORY
TURN-AROUND DOCUMENT
STANDARD REPORTS
SPECIAL REQUEST REPORTS

Figure 11

GENERAL SYSTEM DIAGRAM


COLLECTION DOCUMENTS
INPUT DOCUMENTS
INPUT DOCUMENTS
FILE BUILD AND UPDATE FUNCTIONS
FACILITIES DATA FILE
FINANCE DATA FILE
INSTR. PROGRAM DATA FILE
FILE INDEX FUNCTIONS
PERSONNEL DATA FILE
PUPIL DATA FILE
DATA RETRIEVAL AND REPORTING FUNCTIONS
TURN-AROUND DATA
COLLECTION DOCUMENTS
STANDARD REPORTS
SPECIAL REQUEST REPORTS

Each index is based on the file organization which in turn is based on the manner in which information would most frequently be requested. Report format can be varied and changed from time to time as needs indicate.

PRESS

The Puerto Rico Educational Statistical System (PRESS) is a user-oriented, computer based management information system. It is particularly adept at yielding analytical information through the use of a statistical Report Generator. The basic data units are descriptors of individual students. Information is extracted by a user generated query statement specifying simple Logic and 'Retrieval' PRESS statements, e.g., IF _X_ and _Y_ THEN GET _Z_.

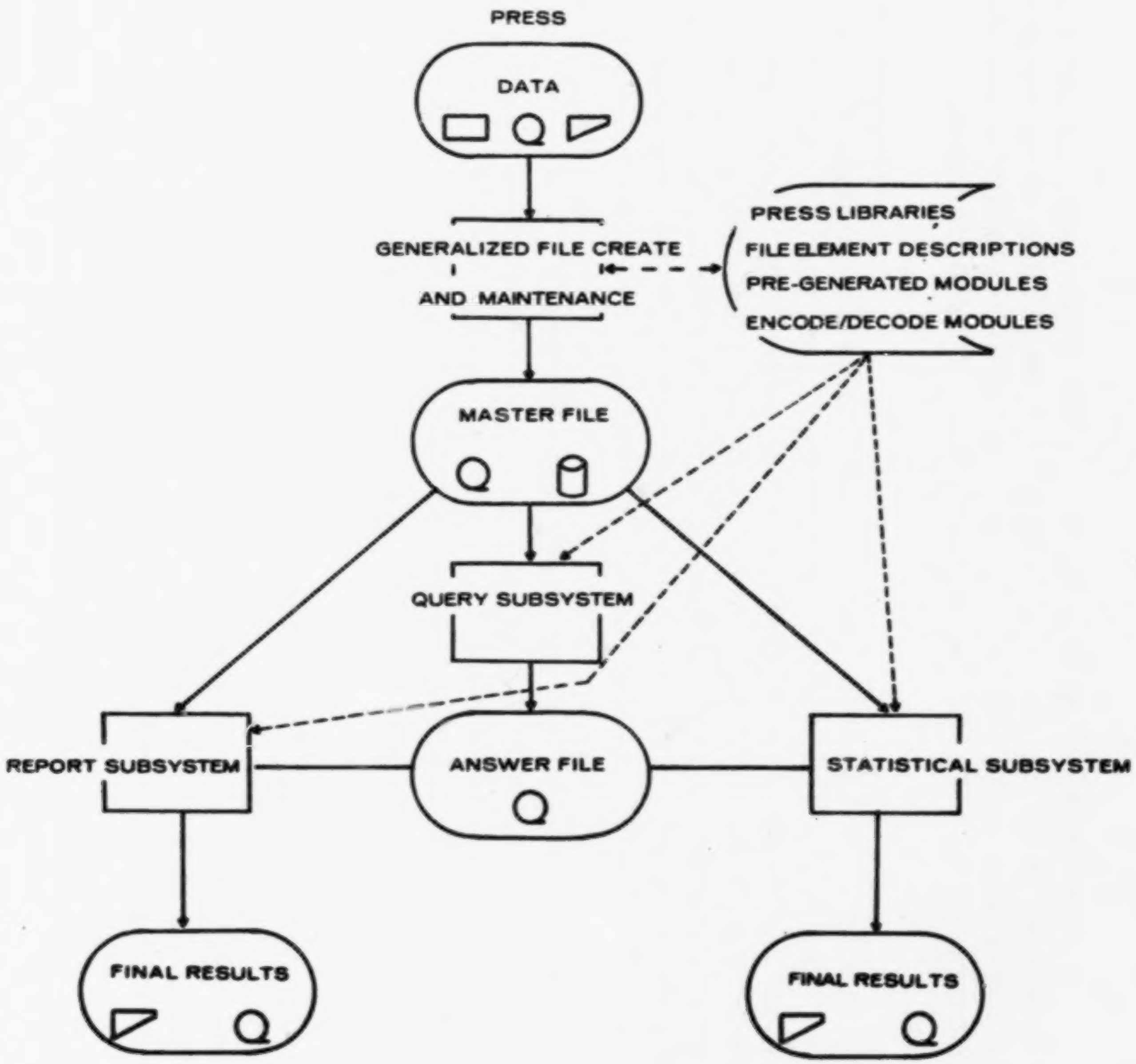
The components of PRESS (Figure 12) are (1) Generalized File Maintenance, (2) Master File or Data Bank, (3) Query Subsystem, (4) Report Generator and Statistical Subsystem, and (5) the Libraries. Some of the major advantages of PRESS are that it is a generalized system; it is user-oriented and by defining the proper file, the user can operate on it with the full power of the system; it produces its own programs for processing the files. The greatest disadvantages appear to be that it requres sizable hardware, (IBM 360 with 128K of memory); files must be created to fit the software specifications; its effectiveness is primarily for descriptive statistical analytical use, therefore limiting the extent to which one can expect both managerial and operational functions to be served.

PRESS appears to be a major breakthrough in the area of making computers user-oriented. It was developed for the Puerto Rico Department of Education by Federal Systems Division of IBM under an E.S.E.A. Title V contract.

Tennessee Adult Education Files

We have just recently created a new Management Information System in Tennessee as a spin-off from an overall study of Adult Basic Education. This is a very simple system in terms of technical problems that are often involved in such efforts.

Figure 12


PRESS
DATA
GENERALIZED FILE CREATE AND MAINTENANCE
PRESS LIBRARIES
FILE ELEMENT DESCRIPTIONS
PRE-GENERATED MODULES
ENCODE/DECODE MODULES
MASTER FILE
QUERY SUBSYSTEM
REPORT SUBSYSTEM
ANSWER FILE
STATISTICAL SUBSYSTEM
FINAL RESULTS
FINAL RESULTS

The system consists of three historical files, all of which have been generated from data which were already available. The three files are (1) Pupils, (2) Staff and (3) Program. Its value is enhanced because each file has the capability of inter-relationship with the other files. In fact, the output of the entire study will involve this element --- and for the first time --- we are finding out what kinds of teachers are conducting what kinds of classes with what kinds of students in them, and where.

There are many data elements that one would probably find desirable that are not included in the system. Our intention is to expand and improve it in this respect as time and other resources permit.

The system is card oriented, tape operated and is geared for annual up-date.

Base-Line Data File

Another example of a management information system, is the Tennessee Title III Base Line Data file which will be used as a data base for assessment and evaluation of Title III, E.S.E.A. It is proposed that the file records be put into machine usable form on magnetic tape or disc pack.

The file will be structured in school district/system sequence. The file structure will consist of three types of logical data records per district/system. (Figure 13)

A. District Data

This type of data record is the "header" for any district's data and will contain information depicting the district as a whole. These data will consist of the physical, fiscal and school population descriptions of the district. The data items under Section I of the data item list (see Figure 14) make up the District Data record.

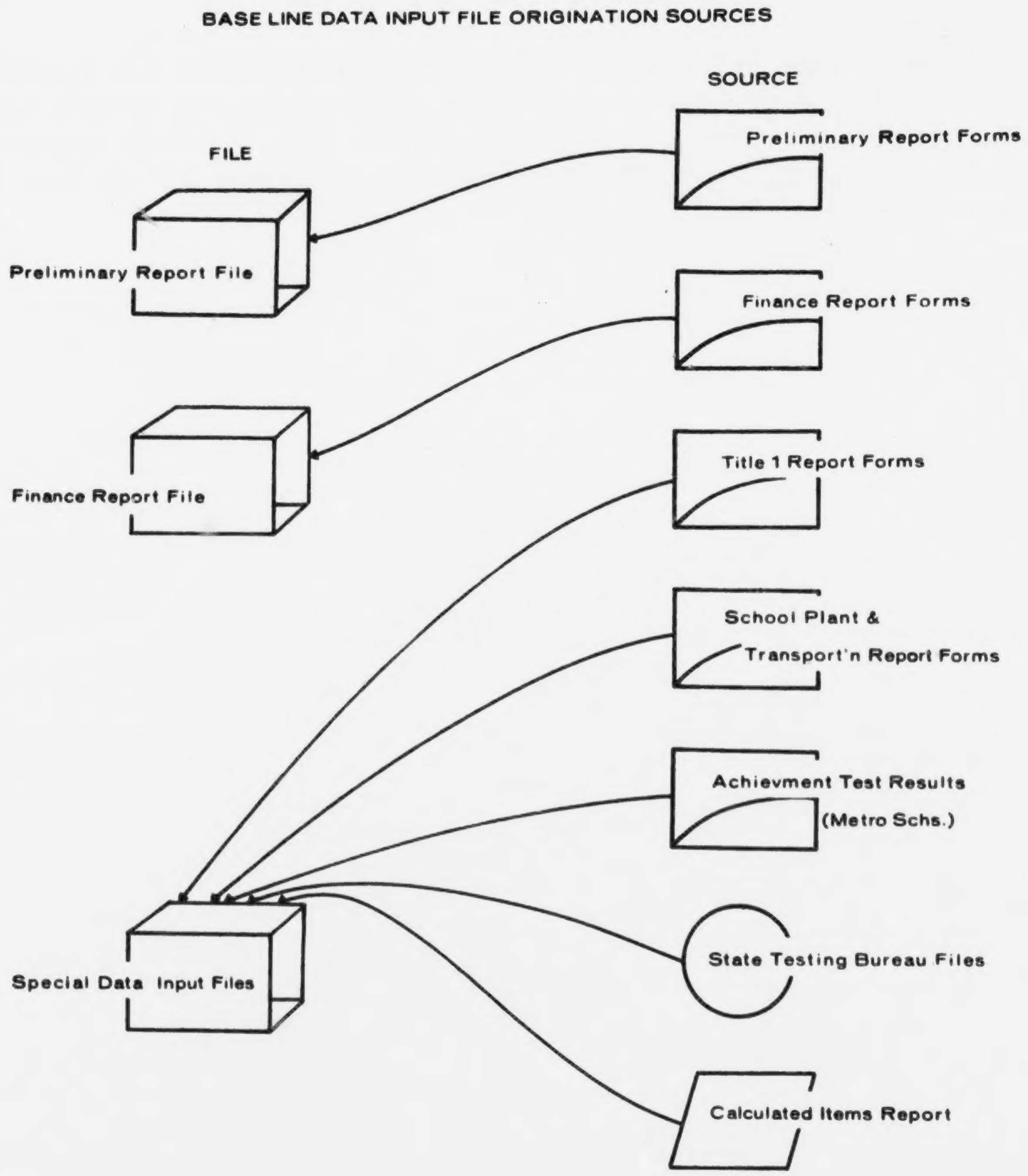
B. Personnel Data

This type of data record actually represents a group of data records, each with same format. There will be a record for each certified person employed by the school district.

Figure 13

1. The File Will Be Structured in School District/System Sequence.
2. The File Structure Will Consist of Three Types of Logical Data Records Per District/System.
    - A. District Data
    - B. Personnel Data
    - C. Curriculum/Assignment Data
3. The Majority of The Data Items Specified in The Data Item List For the Title III Base Line File Are Presently Available in the State Department of Education.
4. There Will Be a Minimal Need to Collect Additional Data Over What Is Now Available in the Department.

Figure 14


BASE LINE DATA INPUT FILE ORIGINATION SOURCES
SOURCE
FILE
Preliminary Report Forms
Preliminary Report File
Finance Report Forms
Finance Report File
Title 1 Report Forms
School Plant & Transport'n Report Forms
Achievment Test Results (Metro Schs.)
Special Data Input Files
State Testing Bureau Files
Calculated Items Report

The record describes each certified employee, to the degree needed for program evaluation. These data are in Section II of the data item list.

C. Curriculum/Assignment Data

This type of record also depicts a group of records. There will be a record for each subject/class scheduled in the district. For elementary grades the records represent grade/selection. These data are in Section II of the data item list.

Tennessee Title III Base-Line Data File
Data Item List

1. DISTRICT DATA	
A. DISTRICT NUMBER	P.R. cards
B. CHARACTERISTICS	
1. District Size (sq. miles)	Special Input
2. Student Population Density	Size divided by total number of pupils
3. Millage Levy	School Plant & Transportation Report
4. Assessed Valuation	School Plant & Transportation Report
5. District Type (City-County)	Special Input
6. District Geographic Region	Special Input
7. Dominant Organizational Pattern	Special Input
8. No. of Schools in District	ESEA Title I form 1 [II 2 (3)] (also can be summed from P.R.)
C. FEDERAL PROGRAM PARTICIPATION	
1. Title I	Financial Report (133.11)
2. Pl 874 and Pl 815	Financial Report (141 and 144)

D. FISCAL DATA

1. Expenditures by classification

a.	Administration (2100)	Financial Report
b.	Instruction, etc. (2200, 2300, 2400)	Financial Report
c.	Pupil transportation (2500)	Financial Report
d.	Fixed Charges, etc. (2600-3100)	Financial Report
e.	Capital Outlay (3200)	Financial Report
f.	Total Expenditures	Financial Report
g.	Expenditures per child for instruction	Calculated item 1D1b divided items 1E1)

2. Receipts

a.	State Revenue (130)	Financial Report
b.	Federal Funds (State Adm.) (133)	Financial Report
c.	Federal Funds (Direct) (140)	Financial Report
d.	County Revenue (120)	Financial Report
e.	School District Revenue (110)	Financial Report
f.	Other Revenue (180-190)	Financial Report
g.	Non Revenue (150-175)	Financial Report

E. PUPIL POPULATION DATA

1.	Enrollments by Grade (Boys-Girls)	Preliminary Report Enrollment Data Card
2.	No. of Handicapped Pupils	

3. No. of Pupils by Ethnic Groups	OEO Form ESEA Title I Form 1 (D1 Page 5)
4. Achievement Test Scores (Grade Level by Sub-Test Area)	State Testing Bureau
5. No. of High School Graduates Last Year	High School Diploma File
6. No. of Institutionalized Children	ESEA Title I Form 4 (44)
7. Concentration of Pupils Low Income Families	ESEA Title I Form 1 (3A Page 1)

II. PERSONNEL DATA (A data record for each "Teacher")

A. Teacher Number	Preliminary Report Forms 1 & 2
B. Types of Certificates Held	Preliminary Report, Forms 1 & 2
C. Degrees Held	Preliminary Report, Forms 1 & 2
D. Salary	Preliminary Report - 2
E. Full Time - Part Time	Preliminary Report - 2
F. Ethnic Group	Preliminary Report - 2
G. Sex	Preliminary Report - 2
H. Teaching Assignment (01-08)	Preliminary Report - Teacher Data Card

III. CURRICULUM/ASSIGNMENT DATA (A data group for each Grade/Assignment/Subject code by class. In Elementary Assignments Code will be "ooox" where X is the grade [0-6, 0=K])

A. Grade/Assignment/Subject Code	Preliminary Report= Teacher Data Card
B. Class Code (Section)	

C.	Pupils in Class (Boys-Girls)	Preliminary Report-Teacher Data Card
D.	Teacher Assigned (Teacher No.)	Preliminary Report-Teacher Data Card
E.	Minutes per week (Calculated from hours/week)	Preliminary Report-Teacher Data Card

The majority of the data items specified in the data item list for the Title III Base Line file are presently available in the State Department of Education. Most of these items are available in a machine readable form (punched cards). Those presently not available in this form can be keypunched from forms on file in the department. There will be a minimal need to collect additional data over what is now available in the department.

The data cards produced from the Preliminary Report and the District Financial Report will produce most of the data needed for the Base Line file. The method of "generating" the Base Line file will be via computer programs utilizing the available punched cards and performing the following functions:

a. Extract the described data items from the punched cards. (Figure 15)

b. Arrange the extracted data into the formats of the appropriate Base Line file data records with the necessary sequence control data, district number, and record type.

c. Sort the generated records to assure that they are in the proper sequence (record type within district). The Personnel records will be sorted into Teacher No. sequence and the Curriculum/Assignment records into subject/class code sequence (both within record type and district no.). (Figure 16)

d. A "proof" report or list will be generated from the "new" Base Line file to indicate data that is missing from the file as well as being a means of validating in the file.

A "file update program" will be used to maintain the Base Line Data file in a current status. (Figure 17) This program will utilize data that will be furnished via requests for data initiated with the "missing data report" produced by the file generation program. The file update program will produce an exception report listing items of data still missing as well as erronous data.

Figure 15

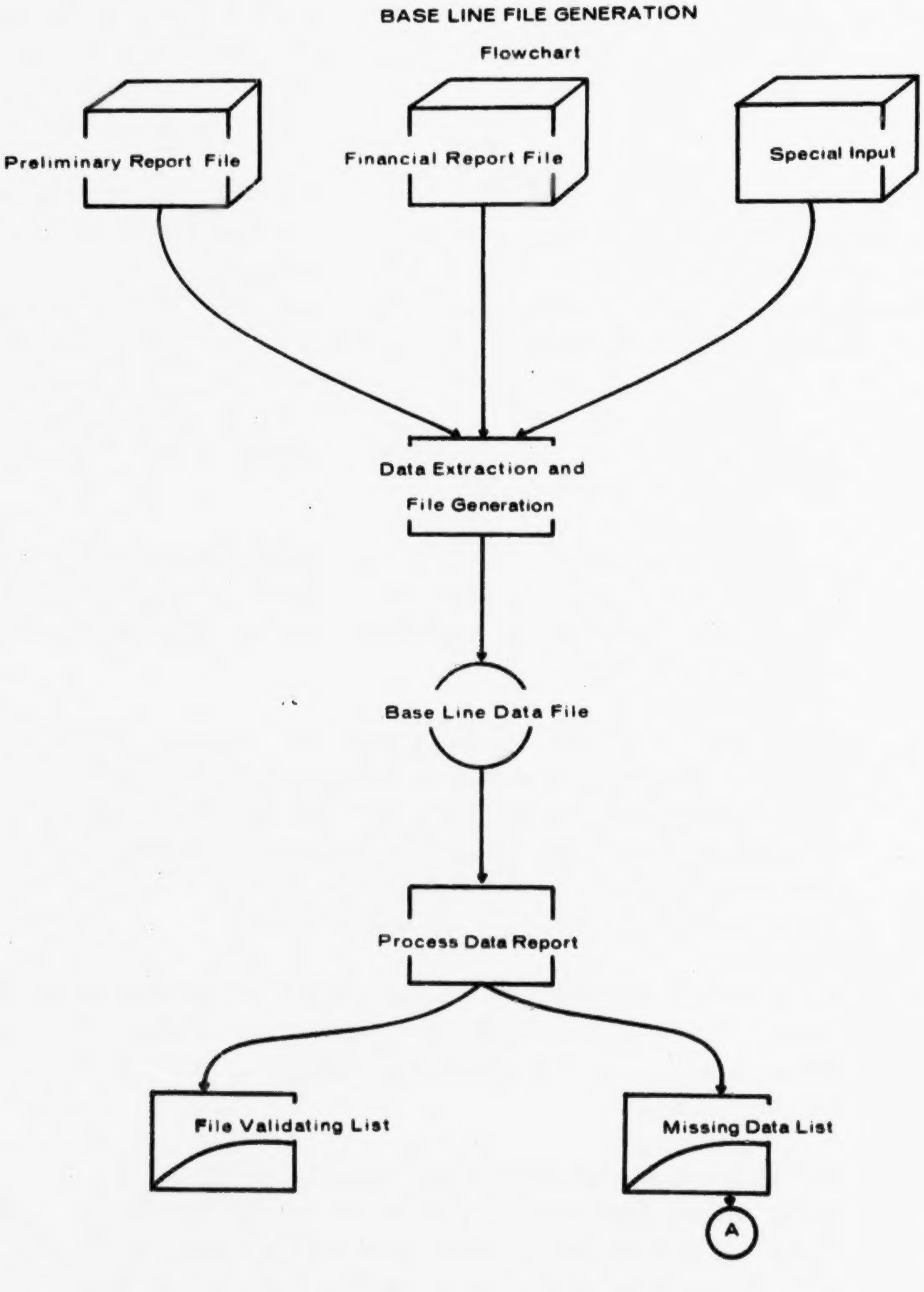
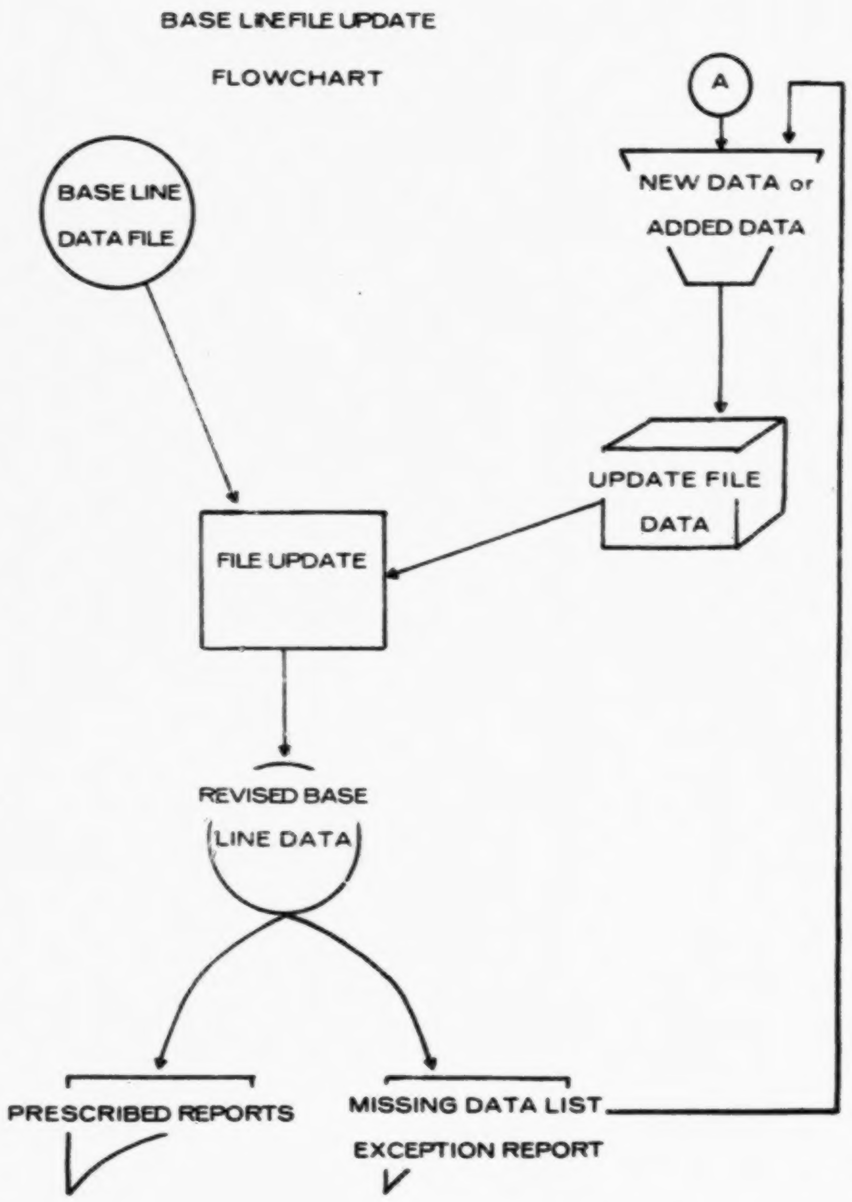

BASE LINE FILE GENERATION
Flowchart
Preliminary Report File
Financial Report File
Special Input
Data Extraction and File Generation
Base Line Data File
Process Data Report
File Validating List
Missing Data List
A

Figure 16



BASE LINEFILE UPDATE

FLOWCHART

A
BASE LINE DATA FILE
NEW DATA or ADDED DATA
UPDATE FILE DATA
FILE UPDATE
REVISED BASE LINE DATA
PRESCRIBED REPORTS
MISSING DATA LIST EXCEPTION REPORT

An Evaluation Information System*

The Base-Line Data File consists mostly of data derived from state reports which are currently being used for other purposes. A need is envisioned for additional information in order to facilitate evaluation on a comprehensive basis. This will be done in the form of an Evaluation Data Bank to be inter-related with the Base-Line Data File or would incorporate it. Such a data bank would be an enlarged "Evaluation Information System." The description which follows is excerpted from Design for Tennessee Assessment and Evaluation of Title III, E.S.E.A.[12]

Characteristics of the Evaluation Information System

1. The "data bank" should have data which would be descriptive of the population groups having relevance to the programs which the data bank is to serve. Sampling techniques employed in building a representative data bank should be applied on a randomized basis or a stratified randomization for students and a saturation sample for teachers. Program data would be collected in entirety.

2. Basic data for the bank should be placed in six files, all of which could be inter-related. Additional program data would determine specific additional files to be added, such as:

   (1) Exemplary and Innovative Practices File - Description of all Title III projects (EPIC now has one).

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*This information system is based on concepts from the Midwestern States Educational Information System, a Title V, ESEA project administered by the Iowa Department of Public Instruction (see MSEIP Documentation) and an on-going program being operated by Project EPIC, A Title III, ESEA project in Tucson, Arizona. (See "A System for Storage and Retrieval of Educational Data," Appendix in "Planning and Implementing Title III Evaluations" by Hammond, Stufflebean and Guba.)

[12] Fred K. Bellott, op cit. pp. 48-49.

(2) Standardized Instruments File - (We now have one at the Tennessee State Testing Bureau).

(3) Behavioral Objectives File - (U.C.L.A. now has one).

The basic data files (6) are:

(1) Facilities

(2) Finance

(3) Instructional Programs

(4) Personnel

(5) Pupils

(6) School - District - Community

3. Redundancy and duplication of effort in reporting would be reduced through access by the State Department of Education to this information system. The local school systems could not only reduce their reporting load by having to report an information item only once, but also they could expect the system to become more useful to them as they gained experience in its use. Remote inquiry capabilities would greatly enhance this prospect.

4. Limited resources of local schools and/or projects would no longer inhibit or restrict them in collecting data. Such a centralized resource would permit larger samples to be used.

5. The data bank would promote a commonality of data collection instruments, uniformity of collection time, and conditions which would yield comparable data that are not now generally available.

6. Continuity of data comparability would be virtually insured in spite of changes occuring in personnel or programs. Longitudinal studies could be made on a broad basis for the first time.

7. With the common reporting base, better data collection procedures should evolve which would yield

additional benefits for the evaluation and the subjects of evaluation. Schools would be encouraged to cooperate more freely and thus experience less interruption of the daily program by the evaluator collecting information.

8. The evaluator would concentrate on extensive analyses and uses of data rather than on the routine physical data collection. His role should change considerably as a result, permiting him to practice in his evaluative domain rather than as a data collector.

The sheer size of the task of operationalizing such an information system makes it an enormous undertaking. The cost for the State of Tennessee would be shocking to the uninitiated. Hardware configurations would have to receive high priority in budgeting to enable the state to acquire the machine capability. It is not a task that could be accomplished in a few months -- rather, a few years should be expected.

The Midwestern States Educational Information Project (MSEIP) has pioneered the developmental work on basic data item identification, definition and coding, and file description and system functions. This system is presently being demonstrated in the state of South Dakota and is available to any state.

The EPIC Evaluation Center at Tucson, Arizona, has developed file descriptions specifically for evaluation. Three of the files listed earlier are presently operational at the EPIC Center.

There is a hesitancy by educational agencies to commit major resources for the development of a comprehensive information system. It is probably founded partly on fiction. There is some tendency to hold back on the development of program specifications and programs, file structures, etc., until all of the components, plus all of the current data for them are available. If everyone follows this procedure, the comprehensive information system will never become a reality. Of Course, it would be advantageous to have everything available, to be able to use the latest techniques and hardware

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[13] MSEIP Documentation.

[14] Hamond, et al.

that would not become outmoded. But if the space program has pursued this course of action neither the Gemini nor the Apollo would have ever been built. Man would have reached the moon if he had waited until he had all the answers to take action.

The outputs from many of the previously identified information systems projects like MSEIP, SPEDE, Card-Pac, etc., are of real value in helping to make procedural determinations about implementation of a management information system. Experiences of others on the use of various input media, for example, illustrate their practicality--using an "op-scan" document for personnel data, a pack of cards for pupil data and scheduling. We already know what the expected error-rate is in updating personnel files when using a "turn-around" document. These data-handling procedures have been thoroughly tested and are in use now.

The technical "know-how" is available. The hardware is available. The needs are real and are becoming more evident each day. The essential ingredients which may be lacking are faith and commitment to the task--faith and trust in our machines and a willingness to commit developmental funding necessary for the establishment of a comprehensive management information system to serve educational organizations.

MANAGEMENT INFORMATION SYSTEMS DEVELOPMENT

Thomas D. Purcell

I. Introduction

The purpose of this presentation is to describe a concept or point of view about management information systems design. As such, it will deal more with a framework within which management information concepts may be considered rather than with recipes as to how to build successful systems.

It has been said that the state of technology today is such that any task that can be described in detail can be performed more successfully by a machine than a human can perform it. Indeed, in many fields of engineering accomplishment, there is much evidence that we know a great deal about getting machines to do our work for us. In the area of management information systems, however, less dramatic success in accomplishment is in evidence.

II. Defining the Problem

For purposes of present discussion, the term "management information system" will be generally defined as a system that performs informational tasks appropriate to driving or facilitating a management decision process of some kind. Such a definition emphasizes the relationship between the purpose of the information system, i.e., to serve a management process. No system so considered may be considered successful, no matter how elegant technically, unless it serves management processes well.

Most of us in recent months have spent some time before the television set observing the impressive accomplishment of the space program. The recent Apollo 11 flight testifies to the ability of man to design complex systems to serve well defined purposes. The flight climaxed a 10-year effort and the expenditure of billions of dollars. In contrast to the dramatic success of the Apollo space flight systems, information systems frequently are dismal failures. One hears a great deal of promotional, inflated, "space-age" claims for management information systems -- how much better our ability to manage will be if we use the sophistication of a computer to help us. Such systems are often feasible, even "beautiful," from a technical viewpoint, but are disappointing in performance. Instead, it is evident that the total, integrated, on-line, real-time, "big-time" management information system has met with very few successful efforts. What are some of the reasons that management information systems accomplishments are so out of line with expectations? Some of the items which contribute to failure are listed below:

PARTIAL LIST OF ITEMS CONTRIBUTING TO MIS FAILURE (RESULTING FROM GROUP DISCUSSION)

1. Poor definition of terms

   Example: ambiguity in the definition of an FTE (full-time equivalence). Such ambiguities not only make communication with technical personnel troublesome but result in difficulties in deriving management decisions from multiple data sources.

2. Conflict in priorities in demands or information processing resources (personnel, equipment, and dollars)

   A related problem contributing to resource shortage problems is failure to wisely use available resources (such as lengthy reports that are not being used in decision processes).

3. Lack of clarity in what to expect of the MIS

   It is evident that a computer is a very general purpose tool and that practically every institution has at least one. It is less clear what the machine should be used for.

4. Manpower problems

   The skills market in information systems technology has been hectic for several years. Turnover has been high, too few people have commanded too high prices with too few guidelines as to how to identify the needed skills for a given job.

5. Organizational and Human Considerations

Several problems relate to organizational and psychological considerations and are the topic of the remainder of the presentation.

III. Organizational Considerations and MIS

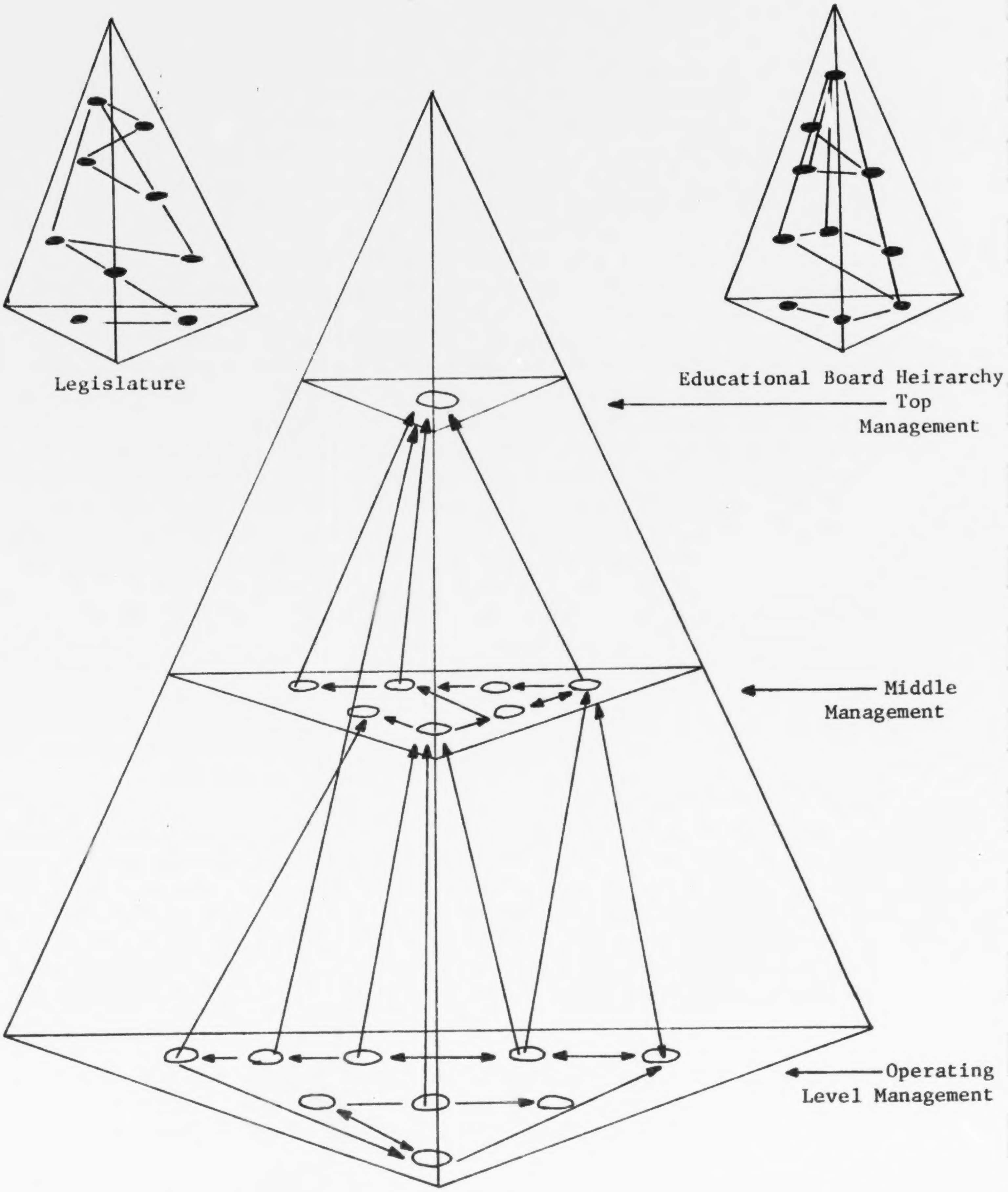
Figure 1 below depicts a typical organization from a traditional viewpoint. As can be seen, it presents an organization as a pyramid with three layers corresponding to the groups of top managers, middle managers, and operating level managers. Circles appear at each level representing organizational functions or offices at that level (e.g., a transportation office, accounting office, stenographic service office, etc.). Lines or arrows interconnecting the circles at a given level represent informational connections between the offices or functions at a single level of management. For example, in a University, a registrar's office may collect information pertaining to student fees and communicate it to a bursar's office which then collects the money. Arrows or lines also flow between the layers of management representing information flow between the management hierarchy in the organization. One arrow, for example, might represent a summary statement prepared from data resulting from fee assessment and collection. Information thus flows between functions or offices both horizontally and vertically within a management structure.

Picture the computer center as an information processing resource as one of the circles somewhere in the diagram. Many of the arrows must flow through this circle, be processed, and re-emerge enroute between functions. Information flow, then, is often not direct but through what is often a "bottleneck." One can see one of the reasons for difficulty encountered in locating such a "bottleneck" in an organization.

There are many organizational and psychological implications to the preceding considerations. It is about some of these that the remainder of this discussion is concerned.

One organizational implication of the foregoing concept is that there is some loss of autonomy by functional units in the organization. Data, for example, finds its sources

Figure 1


Legislature
Educational Board Heirarchy
Top Management
Middle Management
Operating Level Management

INFORMATION STRUCTURE

Horizontal arrows represent horizontal information flow between offices.

Vertical arrows represent vertical information flow between management levels.

in two different offices that have traditionally been independent of one another. These data must now come together for some reporting purposes with the same format. One office, for instance, perhaps used to keep its personnel records in alphabetic sequence, and another in social security sequence. Nobody worried that both of these offices collected data for their collected name, one collected social security number, and nobody cared. But now the machine makes it possible for these data to be merged together on one file, and for the first time a management report produced. Such a situation could result in two offices -- which even report on different lines within the organization -- now being required to collect data in the same format. It would also have to be brought together in time. So the two offices now collect the data not only in the same form, but they coordinate their schedules as well. It is evident that in the process of developing the organizational controls making these things happen, there is some autonomy lost somewhere. There is a shifting of roles, a shifting of responsibilities, or a changing reporting relationship.

In the last several years, computerlizing information systems has come to represent status in an organization. The forward-looking, progressive, promotion-seeking kind of middle management executive in this day and age, if he is not trying to automate, is probably concerned about being overlooked. There is often a great deal of status associated with being in the "space age." As a result, not only are companies doing things on computers they probably cannot justify doing, they are often producing them in six copies when they may not need more than one. Somewhere in the organization, a manager causes these reports to be generated so he can fire copies all over the organization. Somebody knows he's there and knows he's automated, and his computer listing tells you that he is a progressive, forward-looking kind of manager.

Status, then, is one characteristic of automation. However, not only is automation a desirable kind of thing in a status sense, but it is also threatening in that the same people that want to embrace the technology of automation are afraid of it as well. At one time there was a great deal being written about worker displacement, particularly at lower levels. This combination of status and threat is the source of much personal conflict and stress for managers coping with "automation."

IV. The Design Process

What takes place in a design process? Many recipes for design have been offered by different writers. It is apparent, however, that most include in some form, the following activities. It should be noted that each of these activities overlaps considerably with the other. Also, they do not always occur in the sequential position suggested, rather they often occur concurrently. Nevertheless, it is possible to group them for purposes of discussion.

1. Establishing Objectives (What is expected of the system; what are its purposes and the goals to be attained?)

2. Consider Alternatives (What specific alternative routes are being considered; what are the items to be allowed to change in the process of seeking a solution to the problems?)

3. Defining a Solution (This is the residue of the foregoing process of evaluation of alternatives.)

4. Implementation (Follow-up, modification of design, etc., are all included here.)

Establishing Objectives

"What is it that the MIS is intended to accomplish?" It comes as no surprise to persons who have worked in computer centers that purposes of MIS efforts are not always clear. Some seem to be based upon the premise that if enough information is available, management decisions are somehow better ones -- "management by volume" might describe such an approach.

As stated earlier, the present contention is that an MIS should support a management decision process. To the extent that this is a valid contention, definition of the decision considerations will at least suggest the information required. To the extent that the decisions and decision-process is badly defined, the quality of the background information system will be undefined as well. It is paradoxical that our technology of processing information so far exceeds our ability to use it, but such is the case.

As suggested here, the objectives of an MIS depend upon consideration of the organizational decision process. Ideally, an MIS design process should begin with considerations of what information is needed for what purpose and to make what kinds of decisions. Such an approach should allow clear goals and objectives for the MIS to be developed.

Considering Alternatives and Defining the System

Once one decides what needs to be done, only then does one begin considering how to do it. Frequently, it is assumed much too quickly that it's a good idea to use a computer. Considering alternatives, then, one should proceed with automation being only one of the alternatives considered. One should also consider not changing anything.

How will you know when you meet the objectives? How will you know if you have a good management information system? In order to know, one must establish some measures on systems performance. In most fairly sophisticated systems there will always be some residual or failure of error. One should ask, for example, in designing a fiscal information system what is a reasonable amount of error? Can an Accounting Report be off a nickel on a million dollars report? Can it be off 3 cents? It is evident that one may not determine progress toward attaining goals if one is unable to measure system performance.

In developing alternatives one of the things that could be considered in designing a system is whether or not it is permissible to modify the organization. In the example presented earlier, there were two offices that were data collection points feeding into a single system. In the case of a student information system in a University there are frequently many points within the organization at which data are collected: the library, the bursar, the housing office, the student activities office, the registrar, etc. In designing such a system, however, coordinates the bringing together of this information must be considered. How is it to be fed into the system so that it may be processed for purposes of generating reports? The design process may include the consideration of organizational adjustments, as contrasted with simply having to accept whatever exists and work with it as best one can. Not allowing reorganization to be considered establishes design constraints on the degree of sophistication the resulting system can have. If the organization does not coordinate the offices, one had better not try to coordinate the information. At least if one coordinates the data, one should expect problems that aren't programming problems that can't be resolved by adding another shift in the computer center.

Another series of design considerations relative to alternatives relates to the redefinition of work. Computers as part of an MIS frequently change work activities. In making a change, for example, from a manual or a bookkeeping-machine-oriented fiscal system to a computer-oriented one, one is very likely to encounter some frustrated fiscal people as well as frustrated computer people. Their jobs will change, and the "little old lady with the green eye shade" who for forty or fifty years has had every little mark that went in the little book under her personal control -- every decimal point and every comma that's in there she put there herself -- now finds herself talking to some young man who looks as though he hardly shaves yet that knows more about what is happening to her data than she does. He talks a gibberish that she can't understand.

How does one deal with the job problem? Her duties -- what she does at her desk -- change, and perhaps the operation of the whole office that supports the responsibility to be modified. Hence, one must consider the work problem. How will jobs be altered? How will the people be trained that fit into them? How will the employees adjust from a psychological point of view, and how will this adjustment figure be dealt with? Over what time span does one expect this redefinition and adjustment to take place? As a general rule, the more rapid one expects it to take place, the more disruption there is likely to be and the stress generated.

It is evident that there are a lot of things about the organization and about the work of the people that are a part of the system that should be considered. How one designs the solution is strongly influenced by alternatives allowed for consideration which in turn depend on the roles defined for the computer center. Is the computer function within the organization, for example, defined as a service function that essentially sells time to the rest of the organization? Rather is it in some fashion a support activity which represents what higher level management wants?

Some additional "non-technical" design problems that must be dealt with in defining an MIS have to do with work. Staffing levels that will be required to make the system perform properly, not just in the computer center but in the office served as well, should be studied at some point. The transfers that will take place, if any, and the retraining must also be designed. It is often forgotten that retraining activities don't spontaneously occur because they are needed. They have to be planned for and the staff procured to give the instruction, etc. In addition, one may require wage evaluation studies so that one may establish new job categories (for example, a computer center coordinator function within a using office, or a data clerk manager, or something of the kind to do the interfacing with the using office and the automation center).

One must give some consideration in implementation of a system to the phasing and the timing, the paralleling that needs to take place. Much of the time when the new information system comes up because it's prone to having problems, one continues with the old systems and carries through with the new ones in parallel awhile and at some particular date discontinues the old ones.

It is possible that during the period of parallel running, the time during which workers are trying to do both, one may need some temporary additional staffing. People will be trying to keep up everything they always used to be doing while learning a new technology and adjusting to it, etc. So, one may need some temporary staff increases during the parallel period.

In managing the schedule of implementation, it is important to recognize that many of the typical requirements on the machine come in peaks and valleys as do requirements on staff. One must plan some load leveling or end up with all reports due out on the first day of the month and nothing coming out on the third. Real life just doesn't work that way most of the time because such a situation requires a big enough computer and a big enough staff so they could get everything out on the first day of the month and then sit on their hands for three or four days. The load-leveling functions one wishes to apply, may imply some modifications within the organization, so that instead of getting a given set of reports out on the first -- although it has always been done that way -- one report gets out on the first and a second one on the second, etc. In summary, the implementation phase is the point at which everything goes wrong for a while and then, if the design has been good, begins gradually to improve. Needless to say, it is the period of greatest -- sometimes traumatic -- organizational and human stress.

V. Summary

In summary, what has been suggested is that automation brings -- whether planned for or not planned for -- some organizational and human stresses and strains. An organization and the people in will undergo some psychological stresses and strains as a management information system is brought up. The suggestion emphasized here is that one recognize it for what it is and manage the change; plan for it; deal with it; work with it as organizational and psychological change. Don't confuse it with technological difficulty. It is difficult to tell sometimes which is which, but at least admit the hypothesis that it may not be what it appears to be.

VI. Questions and Answers

> _Question_: You talked about the problems within the organization; how about problems between the organizations when you have two separate controlling factors?

I think generally that the principles I described here apply in either case. What one considers an organization is somewhat arbitrary. For instance, we have two campuses at SIU, and some of the kinds of things I talked about that might happen between two offices that have to provide data for a single information system apply just as well when there are two campuses involved; one just draws a bigger circle.

> _Question_: What about the problem of utilizing and really knowing what you are dealing with in terms; well, let me give you an example in a large city where they want a computer report. Although it worked and they gaged the time and all, it disturbed parents historically in what they expected the time, the kind of report, and so forth, and so they dumped the system. What kinds of preplanning can be done in the PR and that kind of stuff?

Well, in any specific case I think one would have to look at the situation itself to try to assess this. You are not always going to anticipate all of them, and the fact that some group of people over here dislikes being identified by social security number rather than by name which we went through a few years ago, you know, there were groups formed -- they may still exist, I don't know -- that disliked all numbers when you dialed on the telephone, and when they dialed up the telephone they said I want number 4,735,213 instead of the normal way of asking for a number to try to thwart the system.

But education I think, broadly defined, is the approach that is needed. Dealing with it before the fact rather than reacting to it after the fact is what I would plea for inasmuch as is possible, and I think recognizing this aspect of automation is an important thing that the manufacturers and vendors of hardware don't talk about much. They don't warn you about these things. You get the middle of it and things start to collapse and sometimes it's not clear why, because you were told that all these if you just have a fast enough machine and a big enough machine and enough terminals and "zap"; all these good things will happen to your organization, and instead, they are bad ones -- at least in the early stages. Appreciate the reason behind this may be that your concept of what a management information included was not big enough. Much of the time you thought only of what happened at the machine, and what was happening was at a lot of places in the organization and not just at the machine. Education, I think, honesty on the part of the people that are marketing. Computing literature is surrounded with a great deal of promotional statements and it is difficult to discriminate between what is promotional and what is a true statement. We need experts who are able to do this, I think, and who intend to do so. I don't know if I answered your question or not.

> COMMENT: I think the problem that I found and several other people have found the same thing and that is the age transparence. Young bucks come out, you know, as you described the fellow who hadn't shaved yet. There is a gap, but who are you to tell me this is any better than I have lived forty years? So, there is a distrust of the new movement as to whether you are going to be done in by this.

You see, you have several levels at which this is taking place. If you are the guy who is the boss over both, you see, and you hear both stories, how do you deal with it? Your fiscal manager bows his head and says "I have had enough of those so-and-so's over there at the computer center; they re-ran my job 14 times last week, and I'm sick and tired of this automation because I have always had my report out on the third day of the month and ever since we have been on that ding-bang computer over there that does things in micro-seconds, it's not been out until the eighth at the earliest." On the other hand, the computer man comes and he says, "Why those silly people over there in accounting; they can't do anything right; they give us bad data, and then they give us schedules we can't meet, and they give us this and they give us that." You are the guy who has to make the decision to resolve both. How do you evaluate that situation and decide what to do? I wouldn't want to be that guy either.

> COMMENT: There's another problem that I have never heard discussed but we have experienced, and that is the whole area of security and the vulnerability of having all your eggs in one basket. Somebody got into the computer and held up in this case all grades and all credits for two semesters to apply on credential.

I have a fellow that worked for me that was at the pentagon when they had a big fire, and you've seen pictures I'm sure; I think the vendors of the vaults or things use this picture to advertise their fire protection equipment. The tapes just melt and run down to the floor in that kind of a case. So it can happen and it does happen. The only thing I could suggest is that good attention to the vital nature of your files, records management procedures, and backing up your vital records in an appropriate fashion; for example, a simple thing like copying the tape and storing it in an alternate spot can be done. If you've got a one of a kind computer, of course, and it gets bombed or chopped to pieces, that is another problem. Anticipating the need for back-up procedures and back-up files should be done for your vital files. I'm not enough of an expert in this area that I can advise you much, but I do know it is an important one, and we have done some minimal things along that line.

> COMMENT: This can be related to something we've already spoken to, but I'm still, I guess, troubled because in our institution competition for the resources of the computer as far as time presents a real problem because the academic need of this and faculty use of it seems always to take second place to the business office use of the computer because the computer center executive reports to the man who is in charge of the business operation.

There are several ways you can change that, of course. One is an organizational change. If he'd report to the registrar, it would quickly be the other way around I suspect, I don't know.

> Question: Well, let's say that the organizational change is probably not likely; what have been some of the things that have been successful?

Well, I would rather talk about some things that might be successful in theory rather than have been successful here. Some places have an overcharge for priority considerations so that, for example, you can adopt as a practice a policy for running a center on a first come first serve basis except on an overcharge, in which case people can buy an advantage. Things like that work more appropriately when you've got equal status in project claim, as you might have, for example, for some purposes in an academic research shop where you have a lot of faculty research going on, each of which has equal plan and equal status and equal money and so on. At one school, and I thought this must have been an interesting thing to watch, they had an auction bid practice so that the computer schedule was posted and people would bid on it and you could bump somebody else by paying a premium. I don't think that worked very well, but it is an approach.

The answer is here; if you have another objective you want to meet and you know what you want the performance to be, you can design ways to do it, either in the procedures that you prescribe that your computer center people follow, you know, overcharge people that want to bump somebody else, or in your predetermined schedules so that as an institutional consideration people get paid before the accounting office gets records, before students get grades, or something like that. As a policy matter for the institution that the worst possible arrangement I think is simply to leave it to the judgment of the operations manager in the computer center, which is done sometimes simply because nobody else has got guts enough to deal with it.

> COMMENT: There's a discussion of that in a book put out by the American Council on Education over at the computers on campus that deals with that great problem. One of the solutions was, there was more than one of course, some schools just get two computers. Another solution is to have the computer center director report to as high an administrative officer as possible, and this puts the referee in a different arena.

It doesn't change the problem, but it changes the rules by which it is dealt with.

MANAGEMENT INFORMATION SYSTEMS DEVELOPMENT

Larry Hengehold

1. Management Systems Department
   - Staff function sometimes applying functional authority
   - Coordinating agency
   - Interprets the rings of influence
   - Areas of Management Systems

     Forms Control

     Procedure Management

     Records Management

     Work Measurement

     Electronic Data Processing
2. Responsibility for M.I.S. development
   - Areas of responsibility
   - Assignments for areas
3. Organizing for M.I.S. development
   - Management Systems

     Advisor

     Project team
   - Line Department

     Liason

4. Planning M.I.S. development
    - Systems study
    - System structures
    - Data bank structure
    - Subsystem identification
    - System development chart
5. Control of M.I.S. development
    - Budget vs actual
    - Status review meetings
    - Additional request control

In the development of management information systems there are many aspects to consider. But first, an identification of the topics that require coverage. What is a management systems department? What is its function? Who has the responsibility for M.I.S. development? How does one organize the staff of people who are management systems in order to begin management information systems development? How do we plan information development? Finally, how do we control management information development and what are the key elements for consideration in a development situation?

Some of you may or may not be directly related to a data processing section, or a management systems department. Whatever your assignment may be, we will be covering the topic from a two-sided approach so that you will be able to relate to it. We will discuss what the user department's role is. When I refer to the word "user" I mean the customer of the data processing services -- the registrar, the vice president, finance officer, or whoever it may be. On the other side, we will talk about the management systems role either within a department of data processing or separate management system department within the university or institution.

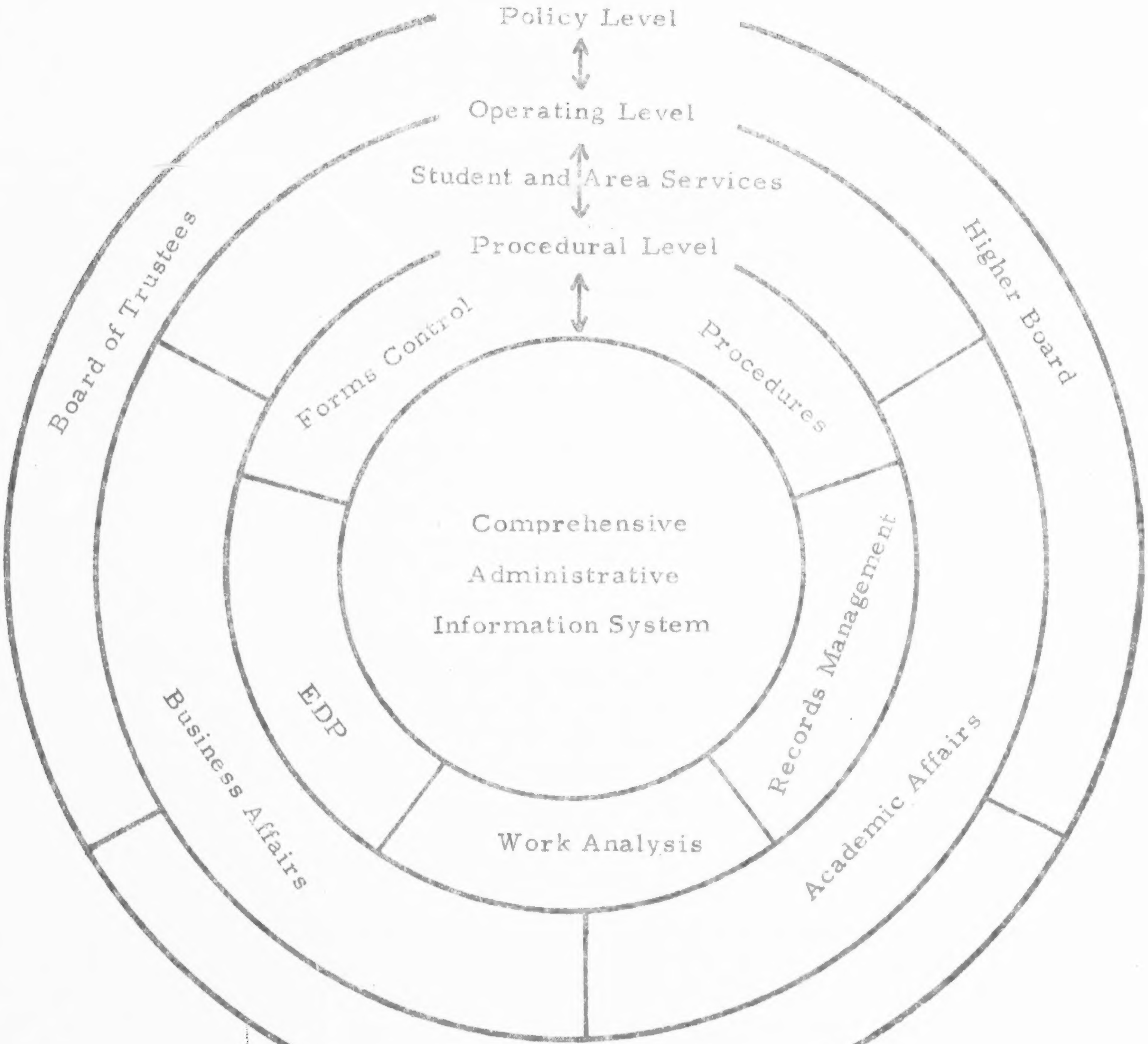
First of all the management systems department is a staff function in the institution which sometimes applies functional authority. Now what does this mean? It is a staff function because it provides services to the institution as a whole. They apply a particular specialty in terms of information systems design, coordination, and etc. Sometimes functional authority is applied in terms that will state that something should be done a certain way for the betterment of the university (by the authority of the person we report to). An account number structure should be a certain way or we must have specific data at a certain time. Functional authority in terms of dictatorial statements sometimes are required to bring the pieces of the information system together at the appropriate time.

Basically though, the management systems department is a coordinating agency. The staff works between departments; between sections of the university or institution. Integration of data many times means designing compromises or arrangements between departments (e.g., a dean of students or a registrar, or a dean of admissions and records). Many times the jealousy between people in various positions will appear. Another example is the arrangements for an institutional research function because they require information on students, payroll, personnel, and fiscal information for cost studies, utilizations, etc. Coordinating, bringing all of these pieces together at the appropriate time and automating it at the appropriate places is the assignment of a management systems function.

There is one other function of management systems department and that is interpreting the effects of the rings of influence to determine the structure of the information system. Figure 1 shows the rings of influence which affect "Comprehensive Administrative Information Systems." This series of concentric circles represents the rings of influence that exist within the organization or institution in terms of the information systems. The outermost ring is the policy level. Here we have the board of trustees, the general administrative officers, and a higher board. Some states have a higher board of education or state agency which influences the institution. The policy level issues general policy statements, in general the direction of the information system. We move down to an operating level ring where we have sections such as the business affairs, academic affairs, and student and area services

Figure 1

COMPREHENSIVE ADMINISTRATIVE INFORMATION SYSTEM


Policy Level
Operating Level
Student and Area Services
Procedural Level
Board of Trustees
Higher Board
Forms Control
Procedures
Comprehensive
Administrative
Information System
EDP
Records Management
Work Analysis
Business Affairs
Academic Affairs
Administrative Offices

departments. These people interpret the policies, make decisions, and imply certain characteristics to the information system. Finally, we have the procedural level ring consisting of five basic areas. By performing in these areas, management systems interprets the rings of influence from the policy level, to design, form, and shape the information system as it is to exist inside the university or the institution.

Now we will spend a few minutes talking about those five areas. I want to do this a little informally so anytime anybody has any questions bring them up at that time when everyone is thinking about the subject area.

First of all, forms control. Here we are talking about an inventory; we are talking about a design situation; we are talking about an approval; we are talking about construction of forms and cost of forms. Any institution will have several thousands of forms floating around. How many times have you designed a form, dittoed it, mimeographed it in various quantities, or purchased on from a manufacturer. Duplicate your efforts by the number of people in the institution or the number of fiscal officers in the university. How many forms do you have? How many times do you have students or other people fill out application data for different reasons? How many times do you repeat name, address, class, etc., on each data collection form? Why not collect it once? All of these questions contribute to costs.

In order to get forms control, you must establish a forms management program. First a manual should be published to explain forms management procedures. A copy should go to all of the fiscal officers and anyone who may have contact with forms in the university. He should know how many, what their cost is, what they're used for, etc. Is your form duplicating another? Is your form collecting the same information as that one? This type of effort can save many thousands of dollars. In many institutions a good forms manager can save two to three times his salary in cost-savings. Another of the forms managers responsibilities is design. For example, you design a form and have business forms company print it. Maybe you are a half inch off of standard paper size. How are you to know what is standard paper size, or what is the standard printing characteristics, etc.? You are not a forms specialist, but if you have the help and advice of a forms specialist, you can save many dollars by obtaining what they call stock forms or eliminating special printing setups. This is part of a total management systems effort. Of course, if you have a central publications unit in the institution, the forms manager will work with that unit. They are part of the program. A forms program is a cooperative arrangement between three functions.

The next area is procedures management. In procedures management we are talking about written procedures for various functions inside the institution. There exists several levels of procedures management. The most general would be, for example, a procedures manual for business affairs. In this manual are examples of all of the forms, requisitions, appointment papers, etc., that affect the business function of the university--normal day-to-day business functions. Each fiscal officer of the university should have a copy so that he may discover how to get something accomplished. I want a work order from physical plant, what do I do? How do I fill it out? What information should appear on it?

AUDIENCE: You are talking about each fiscal officer, how many do you have here?

SPEAKER: I don't remember how many fiscal officers exist, but there are some 350 or 400 manuals. Each fiscal officer and other people do have them. In an academic department, the department chairman has a copy of this book. Any academic department or administrative department would have them. Also, various officials above the departmental level would have a copy of this manual. It is the head of any budgetary unit that might be requesting work.

The manual covers anything from physical services to travel advances, architects, even university housing. Thus, we have a synopsis of all the procedures to get something accomplished. For example, if you were appointed as department chairman or to an administrative position in the university, how do you find out what goes on? First, you might pick up the phone and ask John Doe or you talk to somebody else. However, if you have one of the manuals, you can simply go to it and look up the appropriate information, become conversant with the area and then if you have any questions call the appropriate department head to get the questions resolved. Now that is an example of how a general procedures manual will provide a general direction indication.

Each department or each function in the university should have a set of specific procedures for that particular office. It may encompass many manuals. We might be talking about the accounts receivable section of a bursar's office, or the student evaluation section of the registrar's office or admissions office. Let us use the last example. Perhaps 6, 7, or 8 people perform evaluation of student transcripts. What are their procedures? Are they all the same? Now if one person has a question about the procedure, whom do they ask -- the supervisor? A new trainee, a new person hired in -- how do you train them? A procedures manual cannot answer all the questions. You still must have a supervisor, but the manual is a guide. It is a place to retrieve information about each office. It costs in terms of time and money to build a procedures manual, and it must be built over a period of time. But it is worth it in terms of training new people as they come and go, in terms of providing continual reference information inside the university. Now, what role does management systems play in terms of a procedures manual for a specific office. Well, management systems provides the standardization aspects -- standard format, standard indexing techniques, standard identification of information that should be in the manual, and format for writing. At SIU we have an arrangement with the central publications office. They have a staff of professional writers. The department can outline in rough draft its information and management systems arranges it in proper format. Then the staff of professional people edit it for finalization and completeness of English, etc. Any questions now about procedures manual at this point?

The next area is records management. Tom mentioned this earlier. Here we are talking about inventoring records, papers, documents within the institution. We are talking about retention periods, storage techiniques, and indexing techniques for retrieving those items. A formal approved records management program should exist in the institution. A commission (committee) with authority to establish records retention should be created. How long should an application stay in a file? How long should the payroll information remain in the files of the university? Is there a better method of storing the information? By collecting an inventory of all documents filed, we know what kind of information is available inside the institution and how easily it can be retrieved.

The American Records Management Association did a study of records management programs and developed some of the following statistics:

1) Of all the records, 44% of the records should remain inside the individual office.

2) They found that 24% of the records could be disposed of, useless paper that was not required.

3) And, 32% of these records could be transferred to a low-cost storage facility. A group of people may be set up in a low-cost building storage area to receive and store your documents for a historical reference. These documents will then cost less in terms of storage facilities. They may microfilm them or apply other miniaturization techniques for minimizing the amount of storage space that is required. Thus, the expensive storage space in your offices is available for other use. That is why a good records management program should exist.

Another area is work measurement. Here we are talking about office standards. This is one area that many universities have not worked on. It is a psychological problem area because it involves time and motion studies type of work to set standards on clerical procedures. Watching over people's shoulder, evaluating the best procedure for handling the paperwork, determining how many people are required to do a given job are all part of this area. Work measurement is not very popular but it needs to be done.

Finally, the fifth area is the magic one in today's world, electronic data processing. All of you have been touched by this area at one time or another in terms of automation in one form or another. Therefore, not too much needs to be said about the area.

Any questions about what a management systems department is and what it should do or can do for the institution?

AUDIENCE: Has your procedures for operation of the system pointed out any areas that are not necessary within the system in these major areas, things within the areas?

SPEAKER: Do you mean there's a subsection in some office on campus that doesn't need to exist? Yes.

AUDIENCE: You mentioned thousands of forms, and I wonder if you have devoted time to those?

SPEAKER: Yes, we have. We have one full-time person, the forms control manager whose full-time job is working with and on forms in the university. He works with the printing department, office services, secretarial pool, and the central publications. They have eliminated many forms. Since we are a two-campus institution, one campus would need a form and so would the other one. Normally, they both would develop something a little bit different yet somewhat the same. We've been able to pool purchasing of forms to get quantity discounts. I don't know if we've actually eliminated any subsection or section of a department at the university by changing the forms; but, we have by changing the information system and design.

Perhaps you would consider reorganization as eliminating a function. For example, individual secretaries moved into an office pool using specialized dictation equipment and automatic letter-writing equipment. In addition, we found a situation where all the secretaries and typists were sending out form letters. The form letters were not the same distance from the edge of the paper. The tab alignment was taking time because they had to arrange each letter, put the paper in the typewriter, set new tabs, etc., rather than have a constant tab point. Preprinted forms in terms of form letters can be a time-consuming function.

AUDIENCE: Have you found that the number of forms used has grown by leaps and bounds?

SPEAKER: True. This is an age of information and everybody is thirsty for more and more facts and information. Therefore, everybody is trying to come up with new forms to collect that information and store it. It seems, too, that everyone has a desire to measure himself by how many files that he can have or how much information he can have at his fingertips. Forms and records management tries to balance some of this, while not keeping anybody from obtaining information. Trying to optimize the situation so that he can get the best information in the quickest possible time.

AUDIENCE: We've tried to do some of these things you've mentioned in the way of controlling forms and assuring ourselves that they have some standardization, some aesthetic appeal, good English and all that. We have been fairly successful with business things and with things that have college duplicating and printing service and so forth. But every once in a while somebody wants to send something out to 13 junior high schools. He runs it off on his own departmental ditto machine and sometimes the form will be an embarrassment to the institution. Now, how do you control that sort of thing?

SPEAKER: Well, you are always going to have a certain amount of bootleg forms. Someone is always going to ditto something. The only way to stop it is slap their hands when you catch them. If you have a central publications office and if they are responsible for maintaining quality and controlling the kinds of information that leave the institution (for example, to high schools and other junior colleges, or colleges), they should call to the attention of the administrators that certain department "a" is running a bootleg shop. But, you can best combat this by publishing an information booklet, a brochure which publicizes the program. It should state that you are not trying to shackle the departments but trying to help. You can assist these people with a smiling face rather than trying to take a whip to them.

AUDIENCE: Is it reasonable to ask at this point, can you get people to get information from you rather than from another form?

SPEAKER: Yes, if you can provide timely accurate information.

AUDIENCE: I mean for example, I think of a situation a typical one where each student fills out the same form for each department. Every card is exactly the same and the only difference is the hour and the course but he has to sit there and write name, address, phone number, and other data 15 hundred times. Do you manage to get his name, address, and phone number to the Dean's office, everybody else's office without all that?

SPEAKER: It can be done. It takes a combination of forms, EDP systems design, information systems concept, etc., but it can be done. Here at SIU we have, in fact, done that very thing. A class card does not go to a dean or department. They get their information out of the student information system.

3

AUDIENCE: I saw this tried one time, that's the reason I asked. And, they fell down so that they went back and they actually had a duplicate system operating.

SPEAKER: Well, you can't say that all the information has to be collected on this form and you can't collect it again a second time. It depends on the situation. If you collect the majority of your student information but the athletic program wants to collect address information independently on 150 students, it may not be all bad in terms of 22,000, maybe 23,000 or 25,000 students. So it depends on your situation and combination of events that you're trying to serve and what kind of results you expect. The question you have in terms of getting the information is a matter of timing. How fast does the dean or department chairman know about where this student is, his address, or his classes that he's enrolled in. It's a question of timing -- how fast can you turn the data around?

AUDIENCE: Are you talking about a forms control or management procedure?

SPEAKER: Yes, a management control. It deals with all of these because I can see a need for all of these things within the division we are working. We're talking about 300 people. Is it feasible on that level?

SPEAKER: Look at it this way, here is a forms control program that we would like to have instituted in the university. Define it and write it out, and then start by covering this division or this section of the university first and bring it under control and then move to the next and the next, and so on. So it is possible to institute it, implement it, on an evolving process. But, when you set up the programs, think about the institution as a whole as much as possible.

The second major topic is the responsibility for management information systems development. Figures 2 and 3 graphically represent our discussion.

The first one represents the areas that need control while the second one represents the assignments for control. Using Figure 2 first, we must divide it into two sections. The first section on the left-hand side of the line is

Figure 2

AREAS OF SYSTEMS CONTROL AND COORDINATION

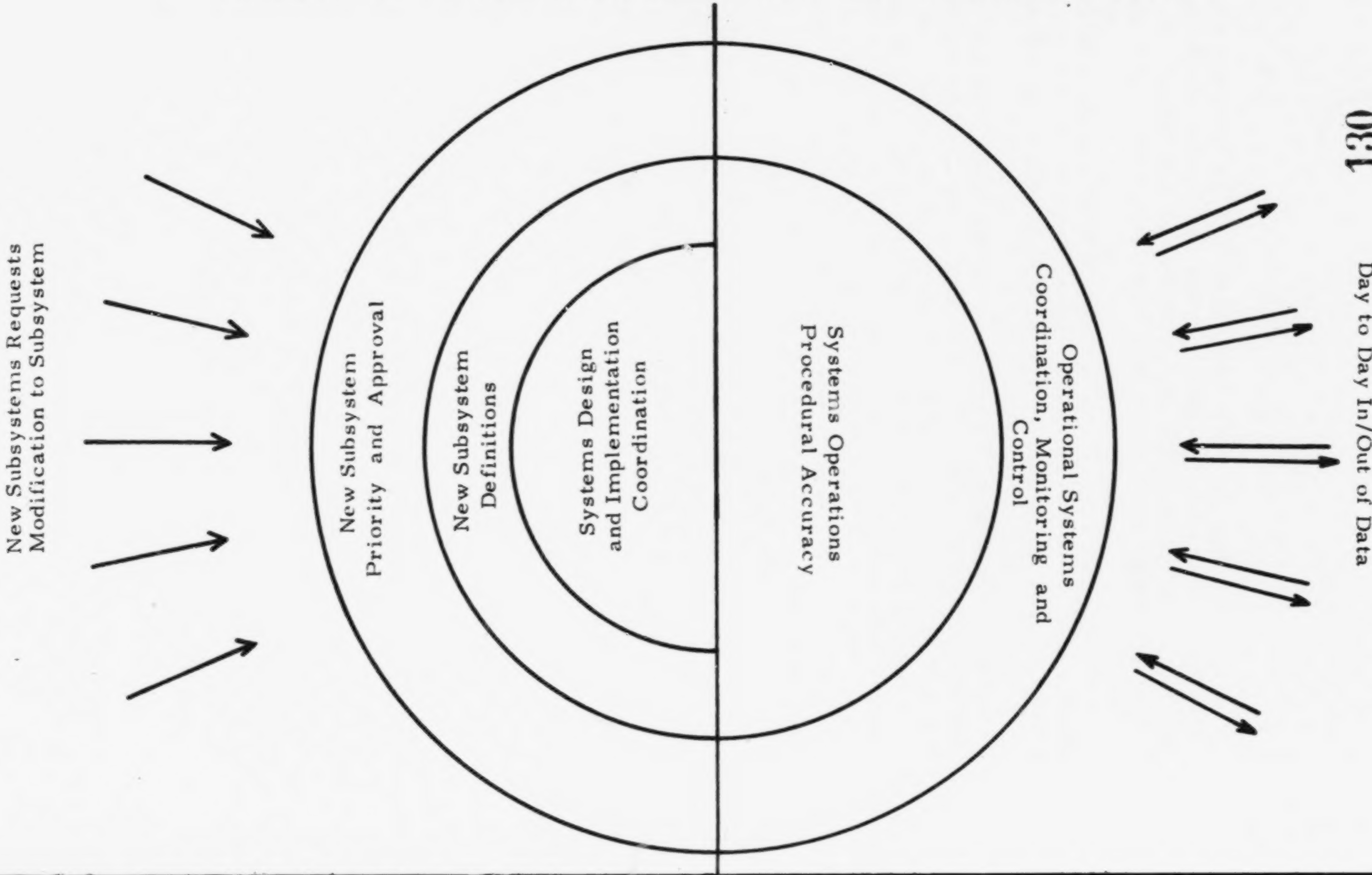
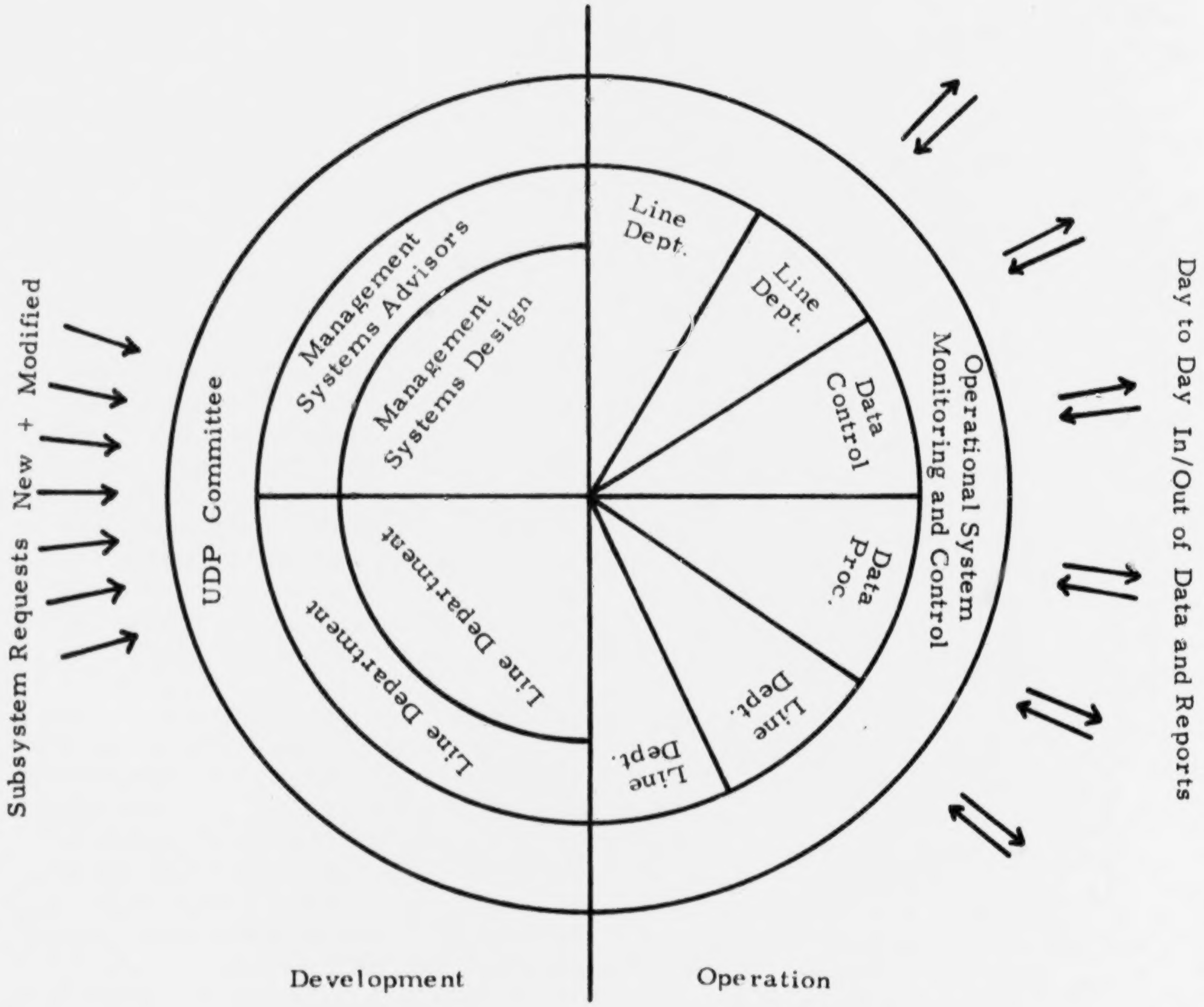

New Subsystems Requests
Modification to Subsystem
New Subsystem
Priority and Approval
New Subsystem
Definitions
Systems Design
and Implementation
Coordination
Systems Operations
Procedural Accuracy
Operational Systems
Coordination, Monitoring and
Control
Day to Day In/Out of Data

Figure 3

ASSIGNMENTS FOR SYSTEMS CONTROL AND COORDINATION


Subsystem Requests New + Modified
UDP Committee
Management Systems Advisors
Management Systems Design
Line Department
Line Department
Line Dept.
Line Dept.
Data Control
Data Proc.
Line Dept.
Line Dept.
Operational System Monitoring and Control
Day to Day In/Out of Data and Reports
Development
Operation

the development of information systems. On the right-hand side we have the operating areas of responsibility for information systems. During development people are going to have certain responsibilities. Once it is implemented the responsibilities will change. The same people who developed it cannot operate it. The reason will be obvious as we discuss it.

New subsystem requests or modifications to subsystems come in continually as shown by the arrows. They may be for full information system, modifications, or segments leading up to a total information concept. The first circle represents the determination of the requests priority and approval somewhere someone agrees that the request is worth spending time and money. Once it is approved as a project, then it must be assigned a certain priority. This one is first, this one is second, etc.

Next is the area of system definition in terms of the new subsystem or system objectives. We have a title. What is it? How do you define it? If I say it is a student information system, what does that mean to you? Each one of you has a different connotation of those words based on your experience and education. First, the thing that must be done is to define the objectives, limitations, and characteristics of what those words mean. Then and only then can we move on the inner circle and actually design the specific procedures and implement that system. Then we can write computer programs, write customer procedures, design forms, and whatever may be called for in the actual detailed design.

Once the system is implemented we cross the center line and come to systems operation. Here we are talking about procedural accuracy. The first area is individual procedure responsibility. Who insures that data processing performs this or that procedure accurately? What about the other departments accuracy? Finally, there is an outer ring that encompasses all of the individual procedural steps. This area is coordination, scheduling, and control of the operating information systems. Usually when speaking of information systems we do not talk about a data bank for a registrar and data bank for the dean of students, and another one for financial assistance. We think about a data bank that represents the university as a whole and crosses departmental boundaries. Therefore, political control or whatever word you want to use must exist.

Now that the areas are identified let us proceed to the assignments of control and coordination. First, the entry point for new subsystem requests, modifications, etc. We suggest a university data processing committee composed of members from various segments of the university for approval and priority determination. After the approval and the priority determination, we move to the new subsystem definitions stage. This is a split responsibility between management systems and the line department. The task is to get the definitions written down. It cannot be the responsibility of one person or department because in management systems you just don't automatically design some magic formula which is going to work. Management systems people do not know all things. They do not know just how a system should work. The line department people have the knowledge about what happens, what problems exists, what they are trying to accomplish. Systems personnel provide certain expertise in terms of techniques and methods to solve problems. The two groups working together will get the problem defined. Neither department controls the other.

After the definitions are written the next stage is the actual systems design. Again it is a shared responsibility situation. If the line department dictates to the systems people, it will cause some inefficiencies and create problems later on in the system. Or if the systems people do the dictating they may over-look areas that must be part of that information system. Together a complete development task can be accomplished.

Then as we cross the line to the operations side; each line department that has a role to play must guarantee its own procedural accuracy. In other words that manager, that supervisor, or whatever the title may be, who is collecting or preparing information must maintain his own procedural accuracy. Data Processing's operations section, the people who run the computers day to day, must do their part in maintaining their own procedural accuracy. There is one other department which you may create and it is called data control. If you have many many departments that are trying to feed into the same system, it might be to your advantage to create a function called data control. They are a watch dog or caretaker. If the data has to be in on 5 o'clock Friday, they make the proper telephone calls, collect the data, and act as a transmittal agency to insure it all arrives on time, and that the reports get distributed on time.

The outer ring represents overall operations system management control. This assignment will depend on each individual institution. Maybe it's an assistant to the chancellor, the vice president, whatever the title might be--some one who inserts his fingertips and monitors the operating system. In many cases in a fiscal division system the chief accountant is the person who monitors or coordinates. Some institutions may call him a controller. The important part here is that management systems does not play a role in the operating of the system. They only participate in the development of the system. Its purpose is to develop, modify, change monitor systems and not operate systems. If ten people develop systems and then play an operational role to patrolling those systems to make them work, you are in for expensive trouble, because you need ten more people to bring up the next system and ten more for the next one, in addition, this approach duplicates work. Many times this is done because someone in a line department will not pick up the responsibility. Probably they have been told "you use the automated system", but they really don't want any part of that information system.

The line department has a very important role otherwise a very expensive failure will exist. It is the line department's responsibility more than it is the data processing or the management systems department's responsibility. They are the line personnel operating the system and making the decisions. Data Processing is a staff function thus an advisory staff. Now that sounds different, I know. Some of you were annoyed about the question that was asked earlier about the young guy who hadn't shaved yet dictating this is the way it should be done. Do not let him control the system because you cannot abdicate your responsibility in any informational area. It is yours. You have to play your role in operating the system, defining it, and making it work.

The third topic for discussion is organizing for management information systems development. In the areas of responsibility I stated management systems advisors do the definition of the subsystems, concepts, terms, whatever it might be. This person should be a senior systems advisor. When the initial request for a problem solution is approved the task is assigned to a senior advisor. His job is problems definition. What is the problem that we're trying to attack? His job is subsystem definition. What pieces make up this problem. What subactivities in the university are part of this problem? His job is making office studies by visiting that particular office and talking to the people who are doing the job. Not just a supervisor, but the clerks who are actually processing the work in order to find out what is going on, what the characteristics of the job are, and in conjunction with those line departments formulating a strategy to design and implement the problem solution. Nothing has been done with the information system yet except try to define it. If this task is completed correctly then good information systems can be designed. If this job is incomplete because of wrong information, then the system is doomed to failure.

After a systems study is completed, then a project team can be assigned. A person named as project leader with possibly two or three people can make up the team. Their function is to take the definition and within the bounds of that definition, design in conjunction with the line department the actual subsystems, write the procedures, write the computer programs or whatever else might be required to implement the system. Afterwards for a series of months or whatever might be required, they will trouble shoot the system working out the bugs and the problems. During this entire process, the management systems personnel worked with the line department.

Before undertaking a systems effort ask the line department for a liaison person to be assigned full time to the effort. This liason is usually a staff assistant to the department head. If it is the registrar's office it may be the assistant to the registrar who doesn't have a line function in the registrar's office. The staff assistant in the fiscal division should be relatively higher than the subdepartment level (e.g. Bursar) of the organization. The liaison participates in the definition, in the design, in the implementation, and provides the continuation for operating and coordinating the system after management systems leaves the project. If a clerk processing data has questions to ask she goes to the liaison. The liaison is the expert for the department, not management systems. Thereby, we get the continuity for operating system. A few systems people can move from project to project developing the various segments of the information system.

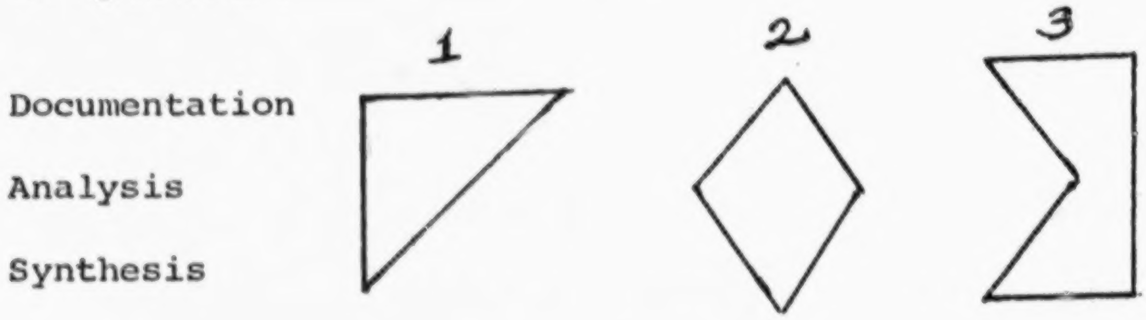
AUDIENCE: Is your project team leader a different person than your senior systems advisor?

SPEAKER: Definitely a different person. Definitely and deliberately. Many institutions have found themselves trying to search formoney because some day the analyst wants more money or he is leaving with all the information about the system in his head. We don't have that problem. Oh, we try to keep people happy, but the information is in two person's heads, the person who did the definition and the person who did the design.

If you have combined analyst/programmer shop, everyone is expected to be able to do both analysis and programming. But the senior advisor has been around the longest. He knows about the politics and the internal characteristics of the university. All the things that can make or break a good system can be best observed by the senior people who do the definitional work. It really works because you sit down to make sure you have completed the homework. When you're through you can say, "yes I know what this system is all about, I understand what the words student information systems means". It is a check-point. In the first session we actually had one of the liaison people describe his role because we felt that some people would not believe it.

There is one other point I would like to mention at this time too. I do not believe that there is a person in the world who can be a master designer. No one can design in one step an entire information system. There are too many pieces, too much complexity, too many segments. The system advisor's role is definition of scope, constraints, etc. on the information system as a whole. The strategy sessions would determine what certain subsection of the entire information system and designing sub-pieces or subsystems.

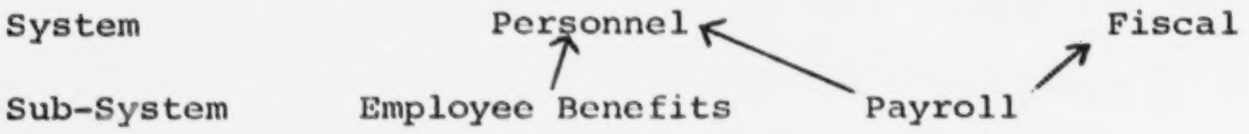
Extending our discussion along this same line we enter the fourth topic which is planning management information system. When the advisor talks to the department's personnel he does what is called a systems study. It is performed in three phases. The first phase is to understand the current system. Finding out what is going on at the grassroots right now. The second phase is determining the requirements for the new systems. Do we have to have this information daily, monthly quarterly, etc? Many kinds of requirements need to be met. The third phase is defining the new system, its constraints, its scope, its problem--orientation, etc. During this process there will be three basic activities taking place. The first is documentation. The second is analysis. The third is synthesis.



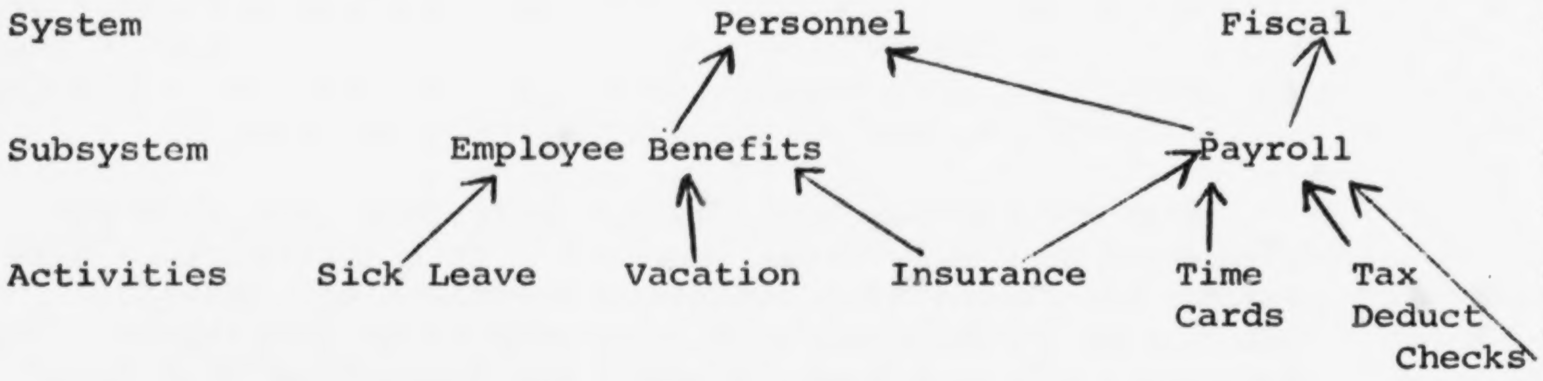
The above pictorial show that the first phase, understanding the current system, most of the time is documenting the activities that exist. Very little analysis of those activities and still less synthesis is performed. During phase two the picture changes somewhat. While determing the requirements for the system very little documentation is accomplished. Hopefully, that information is already captured. The concentration is on analysis of the requirements and very little synthesis. But in phase three which is defining the new system the picture changes. Synthesis and documentation are the key activities with a very little actual analysis. Thus, the definition is accomplished by placing the pieces together in an organized fashion and writing them on paper.

Now the systems study is not different from what you have done many many times yourself. It's applied in a different direction, with different questions and results. But you have completed this very same thing yourselves. You performed the very same things. You documented your data through research and collected the facts, and figures. After analysis of the papers requirements you finally arrived at your conclusion and wrote the paper. It is same process applied in a different aspect toward different goals, different activities.

Now what is it that the systems study is looking for? Well, the process aids the attempt to identify the make-up, the structure, or integration of the information system. What if XYZ institution had to establish a personnel and a fiscal financial information system. What are its sub-parts or subsystems. One would be employee benefits. Another would be payroll. There are many others but this will give a good example. The payroll is a syb-system of the fiscal and personnel systems because of the charge back to the departments for the amount of money paid as salaries. Therefore, the payroll as a subsystem feeds both the personnel and the fiscal information system. Thus, some integration of the information systems appears. These are items that need definition, pictorialy the above discussion would look like this:


System
Personnel
Fiscal
Sub-System
Employee Benefits
Payroll

Within each subsystem there exists many individual activities. For example employee benefits is made up of insurance, vacation, sick leave, credit unions, etc. The payroll subsystem is made up of time cards, tax deductions, other deductions, checks, etc. Each of these activities contributes to the information system. Therefore, the pictorial might look something like this:


System
Personnel
Fiscal
Subsystem
Employee Benefits
Payroll
Activities
Sick Leave
Vacation
Insurance
Time Cards
Tax Deduct
Checks

Again the integration of systems can be seen in the insurance activity because it provides data to two sybsystems. Upon completion of the pictorial the integration of activities, subsystems, and systems can be readily understood. The definition is taking shape. Further work will identify what types of data is passed from level to level in the structure. It will identify time frames, departments involved, and levels of the institutional organization.

Activities can generally be classed as data collection functions. Insurance applications, time cards, and vacation slips are forms used to collect facts for the subsytem. Even a check is a data collection document because it is a "turn-around" document. It feeds still another subsystem such as bank reconcilliation. Another example of a "turn-around activity is the returnable tear off form used in accounts receivable collections.

Subsystems are usually intermediate data massaging functions. Data is assembled, processed, and published in many ways. Publishing may entail passing on summarized facts to a higher level or printing audit trails for historical or reference (e.g. vouchers, alpha lists, etc.). Sometimes multiple levels of subsystems may exist.

Systems cover a broad territory. Generally it represents a broad category of facts which can be massaged to provide information for decision making. Currently experts cannot agree on the exact definition but they generally agree to three categories. These are "the management information system", operational information systems, and minor systems. I contend M.I.S. is based upon simulation and modeling utilizing data from operating systems such as personnel, fiscal, and student. Minor systems are those which do not readily integrate or are smaller in scope such as a library information system.

Enough about system structures because there is more to the definition or system plan. Continuing with the concept that a master design does not exist the next step is to superimpose a data bank structure upon the information structure. What data files must exist? What is their function? What populations are contained in the files? Are they automated or manual files?

Figure 4 represents a technique for representing the data bank structure. It represents the data structure for a student information system. First, the files are divided into three major categories. These are:

Auxiliary Data - Basically an inventory of facts which a relationship with the primary data banks.

Active Data - The files are the primary data banks containing information directly pertaining to the information system.

Inactive Data - These files also relate to the information system but in a historical sense.

The vertical lines drawn between the major categories represent a defined division or transfer point between data banks. The first line in the example identifies when a student progresses from the admission idler to the active student profile. The second line identifies when a student passes on to the inactive student profile.

Down the chart are the various kinds of data banks. For example, in the auxiliary data category exists the admissions idler, people asking to come into the university; a timetable, the listings of sections, quarter by quarter or semester by semester; a course master, all of the approved courses for the university; etc. Auxiliary data is basically an inventory of information that affects the master files. Now the master files in this case, are the active student data banks. The course offerings affect the student files. What sections are open or closed? What courses are offered at the university? What housing is available?

The active data can represent many types of populations, as you can see, because a student traveling from admissions to five years non-attendance goes through various stages of activity at a university. He has applied, been admitted, but not attending, registers, attends, drops out, and he reenters, drops out again, and finally stays away for five years.

So we have various groups, what is called populations, within the active student data banks. The same definition holds true on the inactive data. As in the example the inactive data may have registration information, attendance information, or people who have financial contacts with the Foundation, or alumni activity.

The chart will show those files which can be automated in terms of EDP and those files which may be manual or may be in a miniaturization state. For example, the circles represent electronic data processing files. The rectangles represent what could be considered the microfilm files or the paper documents files. Thus, the auxiliary data contains an admission idler, and EDP file, but also down at the bottom it contains admission document file. It shows a duplication or a back-up file. If something happens to one the other still exists. It also involves looking comprehensively at the information system, not only the electronic data processing, but applying forms, records management, and the other systems concepts.

In conjunction with the data bank structure, a definition of what subsystem data exists in the files must exist. Figure 5 depicts a technique for describing the various types of subsystem data in the file without identifying the specific fields (e.g. name, address, dept.). This form outlines the planned groups of data items that will be in a specific data bank. In the example the vertical double lines identify the admission idler and admissions document file, the active student data, and the inactive student data. Indicated also vertically is the five stages the student passes through. He is waiting admissions, admitted but not in school, in school a possible reentry, and then finally in a history status. Listed down the page is the various subsystem data that will be available in any one of those five states.

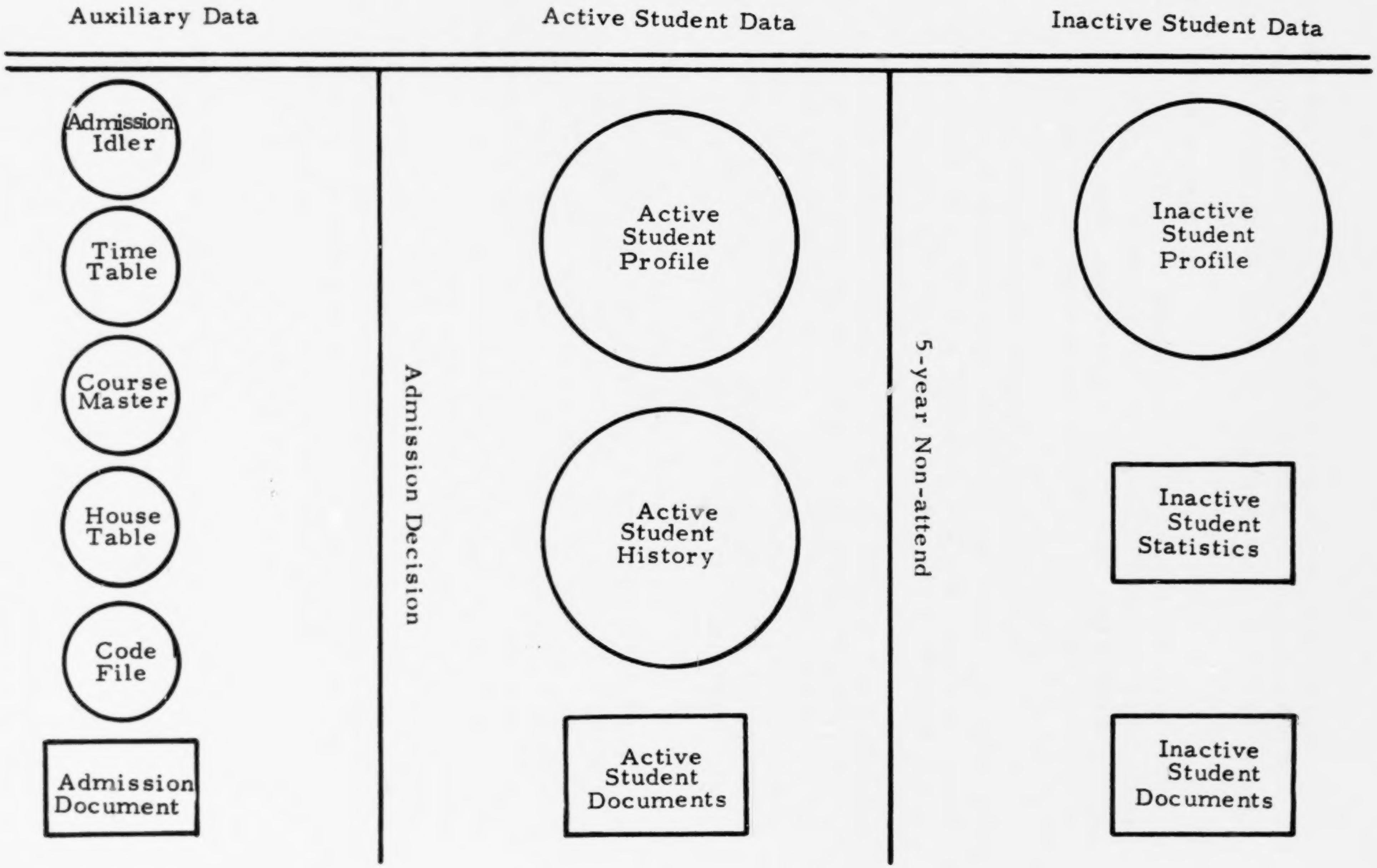
At the waiting admission status exists admission data, readmissions data, biographic data -- (number of brothers, sisters, demographic information), American College Testing Program admissions testing data. This data is available at the time he is awaiting admissions. The admitted but not in school status allows other data to be added. For example, the student may find housing or receive a scholarship. All this information can be added to the data bank because it was defined ahead of time and planned for the system. This is all part of the definitions required to identify what the words "students information system" really means.

AUDIENCE: On this, we have five vertical columns (Figure 4 & 5). Let's just say scholarship data. On this particular sheet, what kind of symbols do you use to provide that kind of information? Is it a symbol that refers to a disc or a card or a tape or what?

SPEAKER: The symbols on here do not identify whether it's card, tape, or disc. All we are trying to do is itemize in an effective definitive fashion the kinds and types of

FIGURE 4

STUDENT INFORMATION DATA STRUCTURE


Auxiliary Data
Active Student Data
Inactive Student Data
Admission Idler
Time Table
Course Master
House Table
Code File
Admission Document
Admission Decision
Active Student Profile
Active Student History
Active Student Documents
5-year Non-attend
Inactive Student Profile
Inactive Student Statistics
Inactive Student Documents

data that will be required. It's a control document in terms of identifying and presenting a definition of all the various pieces in the system. It does not necessarily say that it will be either a tape, disc, or microfilm.

AUDIENCE (cont.): I understand that; that isn't really my question. This sheet is just to help you organize, or is the sheet for a particular student .

SPEAKER: This is for the information system as a whole.

AUDIENCE (cont.): I see, you don't record any information here for any particular student?

SPEAKER: Not on this particular sheet. This is not a data collection document. It is a definition technique to say inside the student information system as a whole we have admissions data, readmissions, biographical, grade average data, testing data, other senior tests or sophomore tests, etc. This is the information that makes up a student information system. It does not show any of the actual system design. So it doesn't show data flow. This is done when you actually get into the design. The actual design process will interpret the definition. For example, a request arrives for a transcript of a student who has been in nonattendance for more than five years. The information can be located in the document file that is indicated here in the inactive student documents and the transcript information will be there.

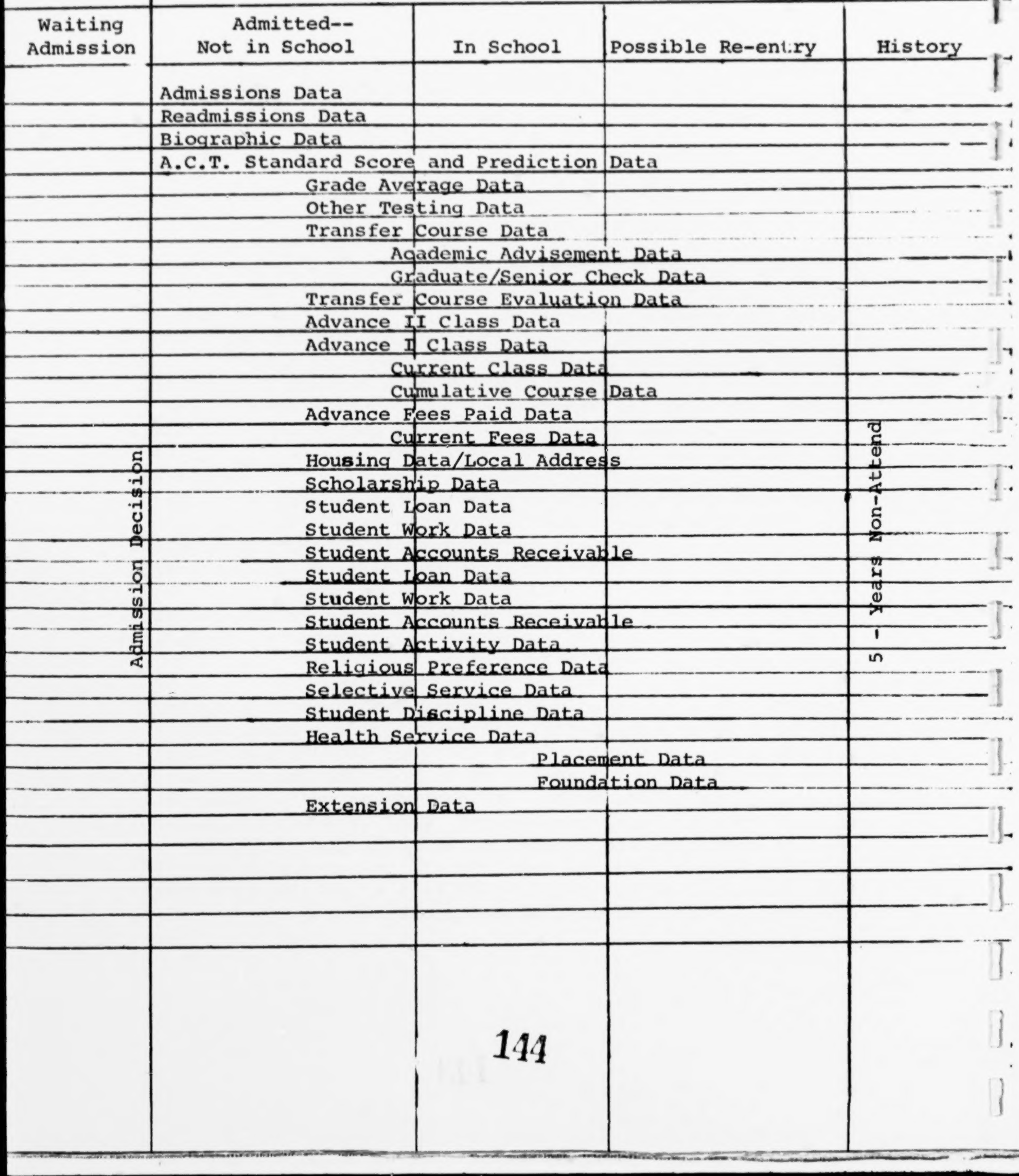
AUDIENCE: At what point do you destroy or make the decision to destroy what kinds of information and preserve indefinitely what kinds of information?

SPEAKER: This is based upon a records management program. This will be brought before a commission or a committee on records management which maybe has your legal advisor and other persons who will advise as to how long you must keep various kinds of documents. It depends on state laws. It depends upon internal regulations, etc. You must have people on this committee who understand and know the university and have enough power to make these kinds of decisions. If the commission do not exist, then it's up to the individual department head. He must make a decision.

dmissions
ocument

Active Student Data
(Profile, History, Documents)

Inactive
Student Data


Waiting Admission
Admitted-- Not in School
In School
Possible Re-entry
History
Admissions Data
Readmissions Data
Biographic Data
A.C.T. Standard Score and Prediction Data
Grade Average Data
Other Testing Data
Transfer Course Data
Academic Advisement Data
Graduate/Senior Check Data
Transfer Course Evaluation Data
Advance II Class Data
Advance I Class Data
Current Class Data
Cumulative Course Data
Advance Fees Paid Data
Current Fees Data
Housing Data/Local Address
Scholarship Data
Student Loan Data
Student Work Data
Student Accounts Receivable
Student Loan Data
Student Work Data
Student Accounts Receivable
Student Activity Data
Religious Preference Data
Selective Service Data
Student Discipline Data
Health Service Data
Placement Data
Foundation Data
Extension Data
Admission Decision
5 - Years Non-Attend

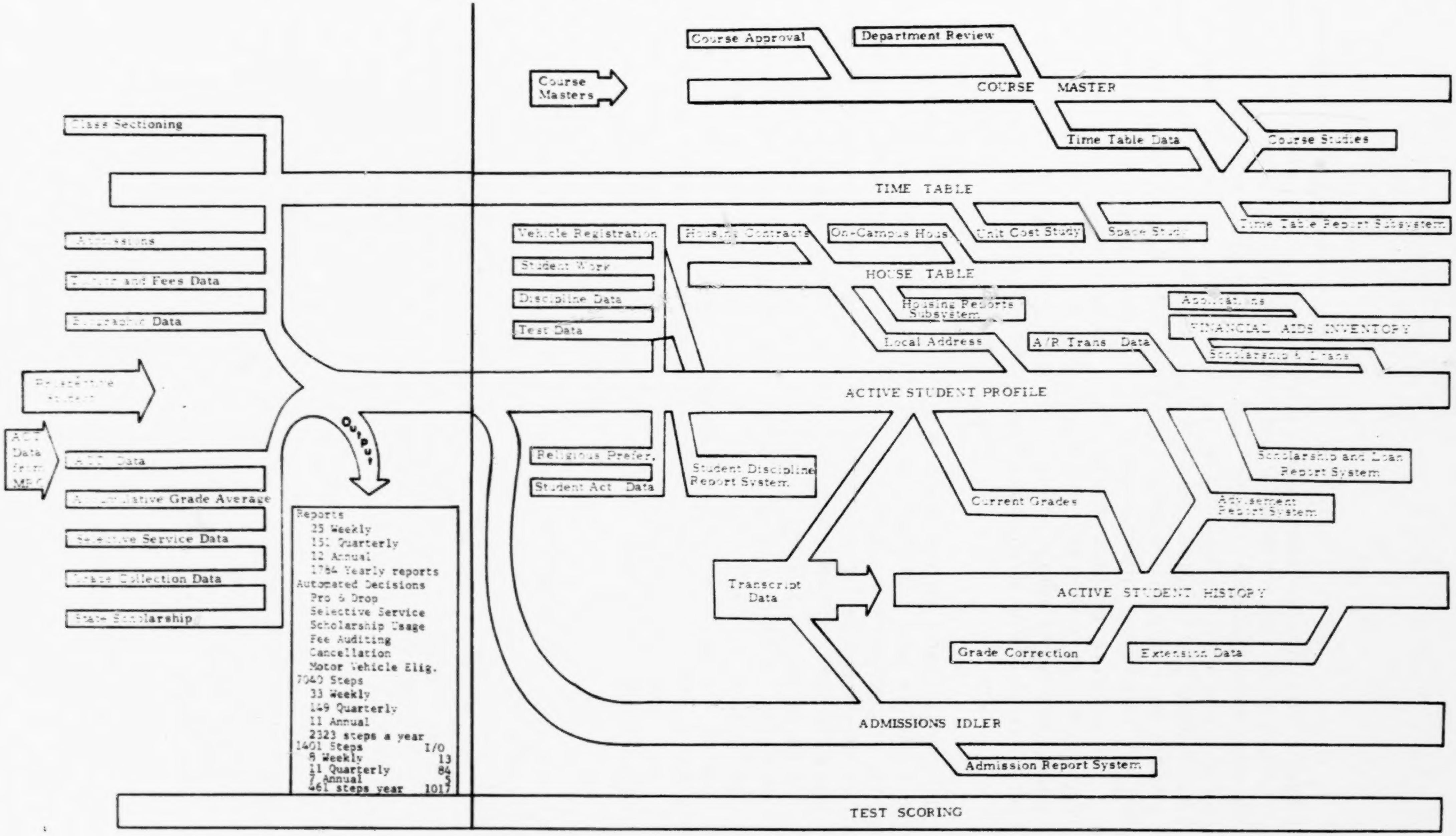
The data banks have been defined and the subsystem data identified. The whole information system has been structured into activities and subsystems. The last stage of planning is to place much of this information in a format to show a planned development effort for starting and continuing toward the assessed goal. Certainly something as large and complex as an information system must be built in stages encompassing many man-years of effort.

Figure 6 represents a technique for presenting the stages of the student information system. Example, the senior systems advisor or planner attempts to build a road map depicting the strategy for action on the information system. He depicts the stages represented by the bold vertical lines. Also, each data bank and subsystem is depicted with its main integration points. If one was daring and bold, an elapsed time frame could be placed across the top of the chart to depict target dates.

The first phase of Figure 6 shows the information that was required to start a student information system. The chart identifies the various segments or subsystems that feed into the data banks. For example, class sectioning flows through the timetable auxiliary file and then into the student profile. By reading the time frame from the left-hand side to the right-hand side, it shows that the Housetable and its subsystems would be designed before financial aids inventory subsystems. These subsystems: class sectioning, admissions, tuition, and biographic, ACT, accumulative grade average, selective service, grade collection and state scholarship can easily be defined as the most basic subsystems in the student information system.

Now that the planning is complete (and approved), the next step is to assign a project team. Commit people to do the design work. How is the design effort controlled? How do we make sure that stages will get finished within a reasonable amount of time? The answers can be found in topic five. As in any research activity there exists a budgeted versus actual situation. I budget "x" number of people for "x" number of days, manpower, to bring up this system over a period of time. Then I capture actual experiences and measure it against budget, against the projection. It is a very simple technique, or it can be a very time-consuming, complex technique, as PERT and CPM.

Figure 6


Class Sectioning
Admissions
Tuition and Fees Data
Biographic Data
Prospective Student
ACT Data from MRC
ACT Data
Accumulative Grade Average
Selective Service Data
Grade Collection Data
State Scholarship
Output
Reports
25 Weekly
151 Quarterly
12 Annual
1784 Yearly reports
Automated Decisions
Pro & Drop
Selective Service
Scholarship Usage
Fee Auditing
Cancellation
Motor Vehicle Elig.
7040 Steps
33 Weekly
149 Quarterly
11 Annual
2323 steps a year
1401 Steps I/O
8 Weekly 13
11 Quarterly 84
7 Annual 5
461 steps year 1017
Course Masters
Course Approval
Department Review
COURSE MASTER
Time Table Data
Course Studies
TIME TABLE
Vehicle Registration
Housing Contracts
On-Campus Hous.
Unit Cost Study
Space Study
Time Table Report Subsystem
Student Work
Discipline Data
Test Data
HOUSE TABLE
Housing Reports Subsystem
Local Address
A/R Trans Data
Applications
FINANCIAL AIDS INVENTORY
Scholarship & Loans
ACTIVE STUDENT PROFILE
Religious Prefer.
Student Act Data
Student Discipline Report System
Current Grades
Advisement Report System
Scholarship and Loan Report System
Transcript Data
ACTIVE STUDENT HISTORY
Grade Correction
Extension Data
ADMISSIONS IDLER
Admission Report System
TEST SCORING

There exists many budget to actual measurements for comparing and controlling the development time frame. The simplest technique is, of course, I assign you to the task for a year and you accept the challenge. You are committed. In effect I have budgeted one person for a year, whether consciously or unconsciously.

Another simple technique is to draw a Gantt chart. Figure 7 is a sample of the Gantt Barr chart technique. The weeks are placed across the top of the chart and down the chart is placed the various analysts who are assigned to that project, Analysts E,F,G, and H. It shows Analyst E will be working on the weekly reports for ten weeks and will start with week one. In week nine he starts and overlaps on the 17th day reports. Analyst F will work on the weekly reports only for 6 weeks and will start sooner on the 17th day. Thus, it represents projected manpower -- budgeted manpower activity. Now, of course, this means for control actual elapsed time will be indicated based upon daily time cards.

The chart should be used in periodic status review meetings. It represents manpower assigned to the task and what the projected timetable is in terms of budgeted activities. It will also show that three weeks or four weeks of manpower have been invested. But, how is the system? Is it a good system or a poor one? There is no real way to measure this except in terms of status meetings. Three levels of status review meetings could exist. They do not have to be scheduled meetings. The best type is "as required."

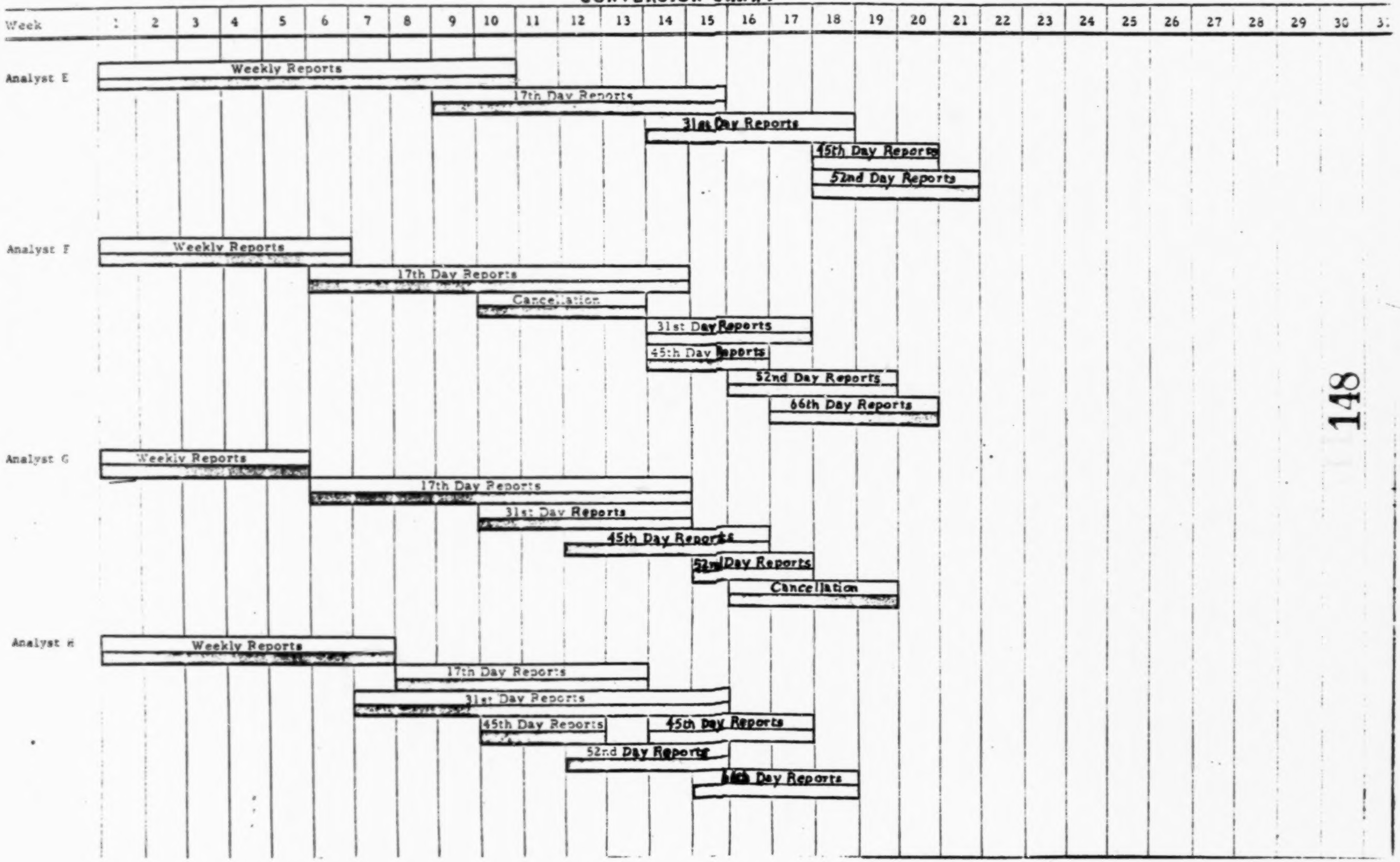
The first one is a project team review. The project leader calls his team together to discuss the project. Is Analyst E going to be ready in time so that Analyst F can do this in time so that Analyst G can do something else on time? How are we doing? Are all the edits going into that program or all the steps into the system by the scheduled time? Is it going to be good quality or bad quality? Reviewing over and over, discussing, communicating, and coordinating the activities. The second level is the management systems department review, The advisor will join in on a meeting to talk about the application. Again -- is it on time according to the charts? Are there any definition problems? How did you interpret this activity? The third level is a status review meeting with the customer. Meet with the line department to keep them informed. They are part of

System: STUDENT INFORMATION SYSTEM

From IBM 7044 to IBM 360

Figure 7

CONVERSION CHART

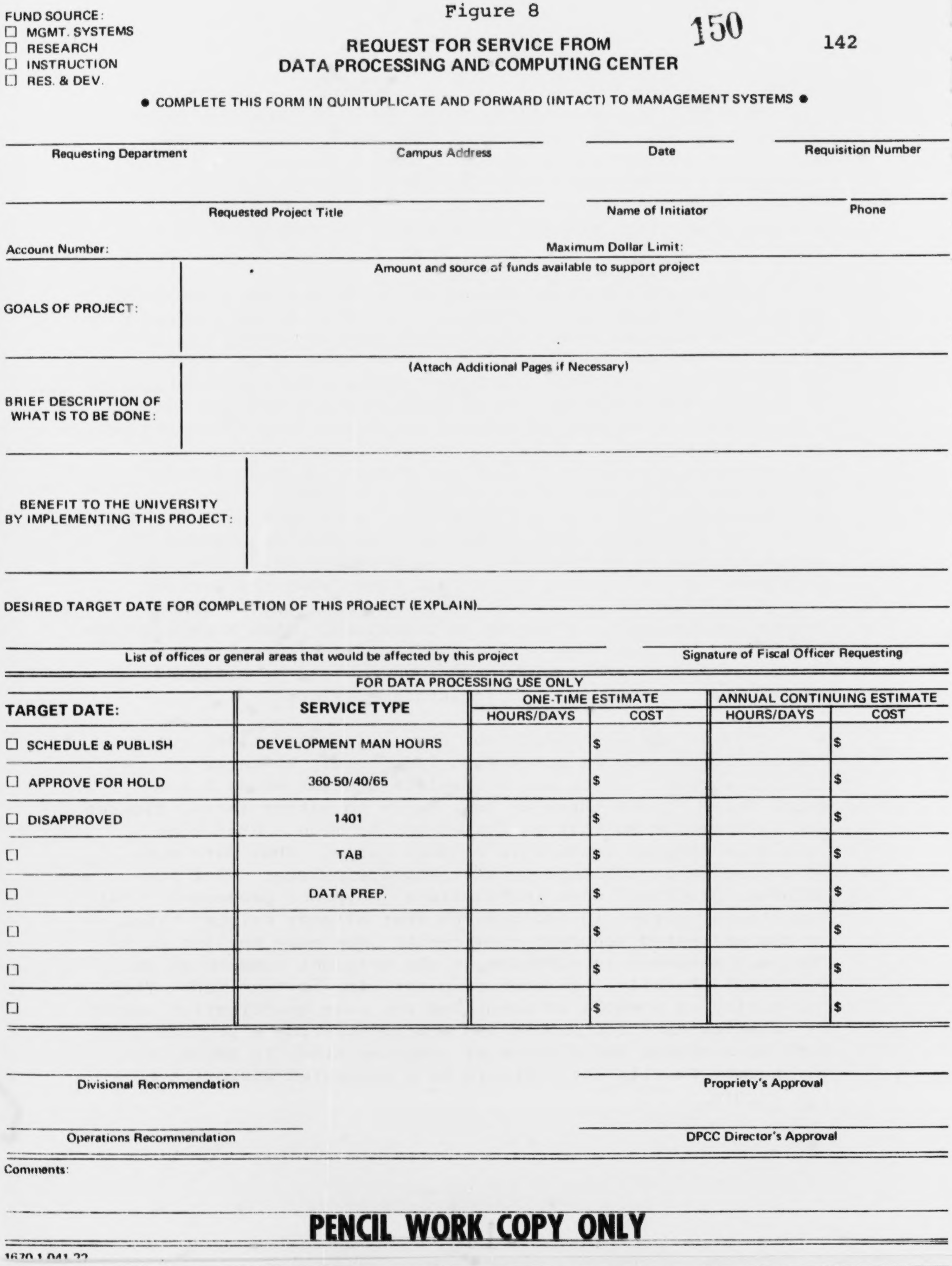


design. How are they doing in conjunction to your part of it? Perhaps they are creating test data to check out the system. Perhaps they are coding massive amounts of information. A library conversion can take a year coding all the catalogue information sheets for converting to automated files. This the library must do at the same time you are writing a program, writing procedures, and completing the system.

Anytime that a large subsystem is in progress, you will always have modification requests. Situations may change during the elapsed time. To control this implement the design first, establish a cut-off on it. Now there is no magic line. It is a gray area and hard to determine when the system is defined and designed. It is time to start writing all the procedures for implementation and write the computer programs. But, at that point stop making changes in the system. Do not announce a week later that you forgot about so and so exception. It is too late. Install a system the way it was designed. Use a requisition form, such as Figure 8. Get a written statement, even a memo or a letter, requesting the modifications to be made as soon as possible after the implementation of the system. It should state what the problem is and what has to be accomplished. Possibly it is an addendum to the system after it is installed. When a requisition completed, the user has officially requested future action. The requisitions containing modifications can be balanced against the overall information system design.

This is the way to control change. In addition, every requisition should be acted upon immediately in terms of an initial survey. It is not a complete systems study but a quick look. Spend three or four hours to gather facts, figures and information so that estimates can be made. What kind of policy changes would this request cause? What data must be collected in addition to what already exists? What procedures, programs, user instructions, keypunch procedures that have to be written in addition to what already exists? What is the estimated manpower commitment? How many analyst days? How much manpower in addition to the original commitment is required? Finally, how much computer time is involved? The university as a whole is committed for some quantitative amount of computer time for production and for testing a program. Does this change add 5 hours of computer time, 10 hours, or 15 hours? Finally there should be a suggested disposition. See Figure 9.

Figure 8



FUND SOURCE:
☐ MGMT. SYSTEMS
☐ RESEARCH
☐ INSTRUCTION
☐ RES. & DEV.

REQUEST FOR SERVICE FROM DATA PROCESSING AND COMPUTING CENTER

● COMPLETE THIS FORM IN QUINTUPLICATE AND FORWARD (INTACT) TO MANAGEMENT SYSTEMS ●

Requesting Department ______ Campus Address ______ Date ______ Requisition Number ______

Requested Project Title ______ Name of Initiator ______ Phone ______

Account Number: ______ Maximum Dollar Limit: ______

Amount and source of funds available to support project

GOALS OF PROJECT:

(Attach Additional Pages if Necessary)

BRIEF DESCRIPTION OF WHAT IS TO BE DONE:

BENEFIT TO THE UNIVERSITY BY IMPLEMENTING THIS PROJECT:

DESIRED TARGET DATE FOR COMPLETION OF THIS PROJECT (EXPLAIN) ______

List of offices or general areas that would be affected by this project ______

Signature of Fiscal Officer Requesting ______

FOR DATA PROCESSING USE ONLY

TARGET DATE:	SERVICE TYPE	ONE-TIME ESTIMATE		ANNUAL CONTINUING ESTIMATE	
		HOURS/DAYS	COST	HOURS/DAYS	COST
☐ SCHEDULE & PUBLISH	DEVELOPMENT MAN HOURS		$		$
☐ APPROVE FOR HOLD	360-50/40/65		$		$
☐ DISAPPROVED	1401		$		$
☐	TAB		$		$
☐	DATA PREP.		$		$
☐			$		$
☐			$		$
☐			$		$

Divisional Recommendation ______ Propriety's Approval ______

Operations Recommendation ______ DPCC Director's Approval ______

Comments:

PENCIL WORK COPY ONLY

1670 1 041 22

Figure 9

INITIAL SURVEY

DATA PROCESSING AND COMPUTING CENTER

Requisition Number ______________________ Req. Date ______________ Target Date ____________

Sub-Project Title ______________________ Surveyor ______________

DATA COLLECTION AND PROCEDURE PREPARATION

ESTIMATE OF DATA PROCESSING COMMITMENT

Development Manpower Estimate			**Development Equipment Estimate**				**Annual Production Estimate**			
MANTIME	DAYS	COST	SERVICE TYPE	NO. OF C. & T.	HOURS	COST	SERVICE TYPE	CURRENT HOURS	INC./DEC. HOURS	COST
ONSULTING		$	360-50			$	360-50			$
ANALYSIS		$	360-40			$	360-40			$
PROC. PREPARATION		$	1401			$	1401			$
			TAB			$	TAB			$
			DATA PREP.			$	DATA PREP.			$
			360-65			$	360-65			$
						$				$
						$				$
TOTALS ▶		$	TOTALS ▶			$	TOTALS ▶			$

SUGGESTED DISPOSITION

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All of these activities put the control of the information system in the hands of the line department where it belongs. Management systems can help the line department with techniques and technology skills, but the line department must make this system a reality.

COST BENEFIT ANALYSIS

Robert E. Schellenberger

Introduction

This morning I want to share with you some brief background information into the whole subject area of management tools, and new developments in the management tools area and then also discuss some references that you may find useful. We should be aware of the fact that some of the initial writing in the area of managerial analysis, systems analysis, or whatever term you want to use, actually dates back to the year 1832 when Charles Babbage wrote a book entitled The Economy of Manufacturers. Babbage is an interesting individual in the sense that he is the father of the current day computer. So we're not talking about something that is a totally new tool. We are talking about a tool which is receiving increased recognition and promises an increased role because of some of the mechanical breakthroughs, such as the computer, which allows us to use this tool in a particularly effective fashion.

Tomorrow, when William Curtis presents the material on PPBS, he will present a specific application to education. You should note that the Association of School Business Officials has begun with a concept of PPBS as taken from the federal government and has utilized that concept with modification for the educational environment. In the process of modification they have altered the title to "Resource Management" rather than "Planning, Programming, Budgeting Systems". The federal government has used this system in the civilian sector of the government primarily to evaluate new program proposals and new activities which the federal government is proposing to undertake.

The structure and the approach are designed to allow the unit (either a university, a local school district, or the state agency) to identify exactly what the agency is attempting to do. This begins with a statement of braod objectives, then moves down to the process of translating broad objectives to something which is in fact measurable, i.e., something against which performance can be measured. As you begin to state objectives, you begin to identify the nature of different kinds of programs, and then eventually you can develop measures against which you can identify whether or not the broad objectives have been fulfilled.

Now, of course, one of the crucial problems involved is the process of translating broad objectives to something which is measurable. This process is difficult at best, and is fraught with some dangers. However, I think we are going to find increasingly that education is going to be forced into this process. As a matter of fact, I brought with me this morning a little blurb on a new type of university charter which has been suggested by President Homer B. Babbage, Jr., of the University of Connecticut. Mr. Babbage essentially proposes that the role of the trustees of the university is to practice as a supreme court or maybe we should say an arbiter between the various individuals concerned with the university; with the faculty, the administration, the students, the public, and so on. If this indicates the direction of the university of the future, we need a considerably improved method of identifying our objectives and a considerably improved method of identifying our objectives and a considerably improved ability to measure the extent to which those objectives are fulfilled. This is really the thrust of PPBS. "Cost-benefit analysis" is an essential ingredient in this process, and that is our concern this morning.

The Managerial Activities

With this background, I want to review briefly the activities of the manager. I think this will be useful from the standpoint of identifying where we are going. The manager is concerned with four primary activities. The first activity is that of identifying the objectives of the organization or unit. Now you'll note that I did not use the term "set the objectives." The objectives of a private organization may be "set" by the management; the objectives of a public organization are essentially "identified." The role of the administrator or local school superintendent is to identify the objectives of that school system. Now that is a difficult process and a process which requires, I think, a good deal of consideration. If we look at the experience of the Dade County group, they have spent something like eighteen months in the attempt to identify the objectives of the Dade County School System. The process has been one of attempting to utilize some kind of a committee structure which represents a cross section of the public, as well as the teachers and the administrators in that school system.

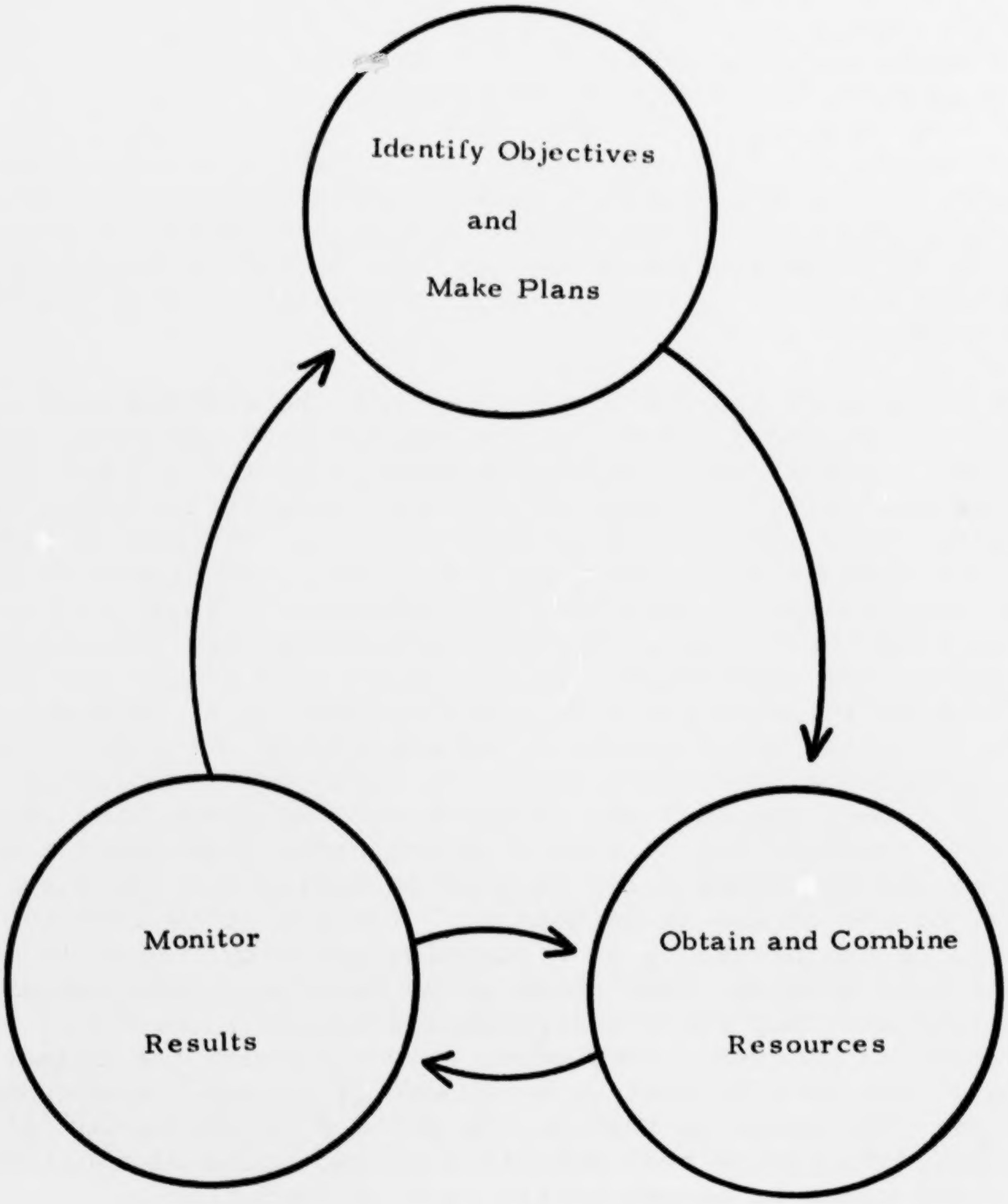
Having identified the objectives of the organization, the next activity is to develop the plans designed to fulfill these objectives. In the management literature, identifying objectives and making plans is called "the activity of planning." But I think it's worthwhile to separate the two. Following the identification of what is going to be done to fulfill those objectives, the next activity is obtaining and combining resources. I use the term "next" advisedly because if you'll look at Figure 1, you'll see that these activities are in a sense cyclical or iterative. So it's not really a process of mix; it's a process of cycling.

Having made the plans, the next activity is to obtain and combine the human, physical, and financial resources necessary to carry out those plans. Thus, having developed the plans, having obtained the resources, we then should be operational; the next activity of management is the activity of monitoring the results.

We monitor the results to see that the desired ends are being accomplished. Now, if the desired ends are being accomplished, there is no necessity to concern yourself. But if a divergence exists between the expected results and the actual results, then the manager is faced with the dilemma of identifying whether the plans were erroneously structured or whether the organization is ineffectively operating. Thus, we see the arrow from the segment concerned with monitoring the results moving in two directions. We may attempt to change the organization to increase its efficiency so that it is consistent with our prospective plans, or we may change our plans. In the process of developing plans, we make certain forecasts. Either those forecasts are in error or conditions have so materially changed that we cannot expect those forecasted results and we are therefore going to have to modify our forecasts, because of the change in conditions. I think it is important to recognize the necessity in a planning activity, which is our focus this morning, that there is an essential forecasting ingredient and that there are potential errors inherent in the forecasting process. They occur either because the organization is not as efficient as we expect or because conditions change. The point is that in the process of making our plans we should recognize this potentiality and build flexibility into our plans to adjust to the kind of conditions.

Figure 1

FUNCTIONS OF MANAGEMENT


Identify Objectives
and
Make Plans
Monitor
Results
Obtain and Combine
Resources

Cost-Benefit Concepts

With that as a background, please turn to the page of the mimeographed handout entitled "Cost Concepts;" we are going to move into concepts of costs, benefits, and some other concepts essential to the understanding of cost-benefit analysis.

Now we are going to cover these cost concepts rather briefly and then work some exercises designed to illustrate the concepts and identify whether we are understanding the concepts. I realize that the background of individuals in the audience is quite diverse and this may be material with which you are entirely familair or it may be material with which you are totally unfamiliar. However, we have to set a common footing before we can move forward.

The concept of fixed and variable costs is a concept which I think is relatively understandable. It's a dichotomy of costs, which is useful when some costs do not vary during a particular period of time and other costs do vary with some known factor or variable. In fact, it is possible that costs would vary with more than one factor or variable, although generally we'll be concerned with situations with a single variable. If we were talking about costs of operating a particular school in a local school district, there are certain costs which are fixed. Salaries are costs which are fixed at least for the period. Weather may have a variable effect on costs. As the temperature drops, fuel costs increase. The most common example is illustrated by the fact that a 1000 pupil school district may cost $900,000 to operate. But adding 10 pupils will only increase costs by $5,000 rather than $9,000. This illustrates that each district has certain fixed start-up costs and certain variable costs vased on the number of pupils.

The next item is probably more conceptual than anything else, and that is the concept of "Future Costs". When making a decision, past costs are useful only to the extent that they predict future costs. The only reason we are concerned with past costs is that they are useful in predicting future costs. They have no other value whatsoever. It is very easy sometimes to use what happened in the past as a guide for the future. Obviously it can be a good guide for the future, but we've got to look at those elements which are going to modify the past costs to reflect what the costs will be in the future.

The next item, "sunk costs," is a concept which does not frequently create some difficulty. Those costs, and this is particularly oriented towards equipment, incurred in the past, are not relevant to a current decision. Assume we are talking about a particular item of equipment, which we purchased at $10,000 that has a ten-year life, and no value at the end. From an accounting standpoint, we attempt to allocate those costs over that ten-year period on some basis. Normally we use "straight line depreciation," which means that we allocate those costs at the rate of $1,000 per year over each of the ten years. Now the accounting decision to allocate costs is merely a way of saying because the equipment is usable over its ten-year life, some costs should be allocated to each of those years. Conversely, if we are concerned with replacing the piece of equipment at the end of the third year, for example, the fact that there are $7,000 unallocated should not affect our consideration to exceed the cost of the new machine, it then becomes worthwhile purchasing the new machine, then the old is obsolete. This means we did not allocate enough in each of the three years of the economic life of the machine. It is worthwhile noting that equipment has both an engineering life and an economic life. Depreciation is allocated only over the economic life and not the engineering life. I think this will be illustrated in one of the problems.

Next let us discuss the concept of "differential costs." If we are considering two or more alternatives, the only cost we need to consider in investigating the desirability of the two alternatives are those costs which are differential between the alternatives. This may reduce the complexity of problems by ignoring those costs which are the same regardless of which decision we make.

The next item is "opportunity costs." Opportunity costs are readily understood, although quite frequently ignored, in decision making. The value of a resource in its best alternatives use is the definition of the opportunity costs. Let's look at the local businessman who recognizes a profit, ignoring any payment to himself, of $10,000 a year on his business. Let's assume he could be employed alternatively in an occupation that would return him $12,000 for equal time investment. He is in fact losing money on his activities because he is losing opportunity to earn that $12,000 while he is earning the $10,000. So the net to him is a loss of $2,000. The concept of opportunity cost is rather a powerful concept. It's a concept which is useful, I think, in considering the kinds of investments in which governments are going to engage. In fact, it might be conceptually useful to compare moon exploration and poverty programs in that particular vein. It is this concept that leads to criticism of moon explorations.

The next concept is the "life cycle costs." It has received increased emphasis in the public sphere largely because of the so-called "line item budget" and the fact that the "line item budget" does not recognize what kind of an obligation is being made for future years. Those costs associated with the project from its inception until its termination are "life cycle costs." One of the inevitable problems is that in some projects the life cycle is virtually infinite, infinite because there is no reason to expect a termination of the project; it is not infinite because of the difficulty of identifying the termination of the project. If there is difficulty of identifying the termination of the project, that's a forecasting problem. The government tends to identify three segments in all program proposals: the R & D costs, the investment costs, and the operating costs, as the cost elements which presumably allow them to get a reasonable fix on the life cycle costs.

Incidentally, if there are any questions, you might wish to raise them. If we get too involved I will simply say, "Let's pass until we get into the example which illustrates it."

AUDIENCE: I'd like to go back to "opportunity costs." How would that apply to schools or more specifically to school superintendents?

SPEAKER: If, for example, you devote instructional resources to a particular program, what you are doing by that process is eliminating certain other potential programs. So there is an opportunity cost attached to devoting these resources to this particular program. An opportunity cost obviously exists with the respect to any particular program. There is obviously a difficulty in identifying what some of these alternative opportunities are, but it's a concept which I think is useful in recognizing that whatever program you undertake, you preclude the possibility of undertaking another program. You are concerned essentially with the efficiency of the school district's operation. If you are in the fortunate position of having the excess facilities, they are really not excess facilities, they are really not excess, because any number of programs might be initiated. So, sometimes, if you go "firstest the mostest" you may be making a great mistake. In that sense the concept of opportunity costs forces you to explore the alternative uses of certain facilities which you might not otherwise do, simply because someone comes first with suggestions for its use.

AUDIENCE: How would you relate this to priorities?

SPEAKER: It ought to help you establish some priorities. However, measuring opportunity cost has its own inherent difficulties because when you're attempting to establish priorities you're not necessarily talking about neat dollar trade-offs. You may well be talking about trade-offs between Head-Start programs and Enrichment programs, and how do you measure the extent to which a Head-Start program is beneficial versus the extent to which certain Enrichment programs are beneficial. It's difficult to measure the trade-off between the Head-Start program and the Enrichment program, but it is in fact a decision which has to be made. If you go ahead and start a Head-Start program, you're potentially eliminating an Enrichment program. If you go ahead with an Enrichment program, you're potentially eliminating a program similar to a Head-Start program. It's something that I would love to discuss further, but now we ought to try to pursue our immediate objective. This might be something we could consider after we go through some of these exercises.

One of the difficulties which we frequently get involved in with this cost-benefit approach is the desire to consider the simultaneous possibilities of increasing the funding for a particular program and increasing the benefits for a particular program. Generally if we're considering alternative programs we can say, "let's look at what an increment of $100,000 will do for our objectives;" then we identify a series of alternatives programs which have an impact on the objective. We can, therefore, pick that program which is going to have the greatest impact on the objectives. So we've held the resource input constant and attempted to maximize the fulfillment of our objectives. Alternatively, we could hold our objectives constant and attempt to minimize the resources which we are utilizing. Either of these two approaches is reasonable. You cannot, however, both minimize cost and maximize objectives. The two with our current analytical tools are essentially mutually exclusive. We can't do both at the same time.

The next concept which we want to discuss is the concept of "marginal or incremental cost." Now this given concept is confined to a situation where the actions can be viewed as a series of alternatives which differ in quantity but not in kind. So we're talking here about attempting to identify the level at which a particular program should be undertaken.

If we're talking about a Head-Start program or an Enrichment program, we are concerned with the level of funding. Should it be $10,000, $25,000, or $100,000. We can look at what it costs to move from one level of funding to the next level of funding and then look at the benefits derived from moving from that level of funding to the next level of funding. From this we may identify that level of funding which gives us or yields us the maximum return.

This concept creates a certain degree of difficulty because the maximum is not the point where the return is highest in absolute terms. It's a concept which stems from economics. If we're talking about the point where we maximize our profits, we don't move to the point where the revenue figure is the highest; we don't move to the point where the differential between the cost of producing a given unit and the return of the given unit is the highest. We move to the point where the revenue from the last unit produced yields a return barely in excess of the cost of producing that last unit.

When we go over the problem for the first time, we're going to ignore certain considerations. One of these is the concept of present value. The concept of present value recognizes that if we are considering two alternative courses of action, one of which requires an immediate cash outlay, the other of which requires a cash outlay of equal amounts over a period of time, and if the returns from these two alternatives are the same, and if the dollars expended on these two alternatives are the same, then we should take that alternative which distributes the costs over the duration of the project, because by spending the money at the outset of the project we have lost the opportunity to use that money in alternative uses. In fact, if we spend that money instead of putting it in savings, we have lost the opportunity to derive income from those savings. Some of the money is still available to be used for returns from the money itself. This is a simple way of identifying what we mean by present value concept. We'll get deeper into it further.

PROBLEM 1

Let me ask you to take ten minutes to see where we stand with Problem One of the handout material. What kind of a decision would you make with the last situation faced or expressed in Problem One?

Problem 1

> The Maintenance and Grounds unit owns six 24-inch riding mowers. Each of the mowers costs $900 new. They are each operated 30 hours per week for 15 weeks of the year. During the remaining weeks they are not used. The employees operating them earn $3.00 per hour (including allocated fringe benefits). They were purchased one year ago and have an estimated three-year life and an estimated scrap value of nothing. Present market value is $100. The school depreciates these machines at $300 per year. The director is requesting that these be replaced by five 30-inch riding mowers at a cost of $1200. These mowers have a life of only two years and zero scrap value. He maintains that the savings in manpower costs will be substantial because he will then need only five men mowing instead of six. Assume maintenance and down time costs are equal. Ignoring present value and tax considerations, should his request be approved? Show the calculations necessary to begin the analysis.

His claim is that there will be a savings in manpower which will offset the cost of the power. Now, we're assuming that there will be no change in the necessity to spend 30 hours per week for 15 weeks of the year and 40 hours per week for 15 weeks of the year per employee. I suspect that in the course of any given mowing season these requirements may vary but that on the average they will run something of this nature. The savings are 30 hours over 15 weeks at $3.00 per hour plus 40 hours over 15 weeks at $3,00 per hour over a two-year period, or a total savings of $6300 in manpower costs because of reduction from six to five mowers. The cost of each of the mowers is $1200 or a total of $6000. By turning in the fleet of existing mowers now, we receive $600, which will reduce the cost from $6000 to $5400. Therefore, we have a net saving of $900 by accepting this decision, if all of the assumptions are correct. This is summarized as follows:

Calculations to Problem 1

Savings

30 x 15 x 2 x 3 = $2700.00
40 x 15 x 2 x 3 = $3600.00
$6300.00

Cost

5 x 1200 - 600 = $5400.00

NET SAVING = $ 900.00

Would anyone care to explore or discuss further the calculations segment rather than the assumption segment?

AUDIENCE: Regarding the statement here to ignore the present value, does that mean we don't deduct $600?

SPEAKER: No, the statement that you ignore the present value means that the value of the savings generated next season are recorded at full value. In other words, the $5400 is an immediate cost, but the savings occur over the next two years. Thus the savings are actually overstated.

Maybe now is the time to move more deeply into the discussion of present value because a consideration of present value may alter the nature of the decision here. You'll have to consult an accountant or lawyer on the impact of taxes. We're talking about an immediate investment of $5400 which generates a savings one year hence or one mowing season's hence of $3150; so if we look at this in terms of expenditures and incomes, what we've got is an immediate expenditure of $5400, and then we've got income here of $6300 spread over two years. Let me see if we can illustrate what is at stake here. Now, what we want to do is be able to compare expenditures and incomes made at diverse points of time. I would like to demonstrate what the present value of a dollar is when it is received one year hence or two years hence. So let us ask the question, how much would we have to put in savings at this point of time so that it generates a dollar a year from now? And let's talk about a 10 percent rate of interest. So if I put in 90.9 cents in the bank now and I receive 10 percent of that one year from now my value then is $1.00. The present value of $1.00 one year hence is 90.9 cents. I should be willing to pay 90.9 cents now to receive

$1.00 one year from now at a 10 percent rate of interest. If I want to receive $1.00 two years from now, I should be willing to pay 82.6 cents. At the end of the first year that will yield 90.9 cents (82.6 + .1 x 82.6 = 90.9). We've already demonstrated the 10 percent rate of interest on this. So what I'm saying is, at a 10 percent interest rate, the value of the income two years hence is really only 82.6 cents now. You see the transition? I'm willing to pay now 82.6 cents to receive a dollar two years from now. Now let's look back and see if we can modify our income figures here.

Figure 2

Savings		
$3150 (.909)	=	$2,873.35
$3150 (.826)	=	$2,601.90
		$5,475.25
Cost	=	$5,400.00
NET SAVING	=	$ 75.25

It still appears to be worthwhile, but it's only $75 worthwhile. Is it worth expending? Have we considered all costs here? Obviously the business office has to process the paper work to purchase this item. It has to be received, it has to be unpacked, we've got to go through the process of contacting somebody to sell the items. So there are some cost items which are probably ignored. So what appeared initially to be at least maybe a reasonable investment now is really an unreasonable investment.

AUDIENCE: Do you have to look at the wage differences between six employees and five? Wouldn't that have some bearing on here?

SPEAKER: Of course that's what the savings are up here. Now another item which we have not considered is that we are projecting the wages of these individuals at the same level in future years. The fact that they go up may have an impact; in fact, the fact that wages will go up will probably tend to support the purchase decision.

AUDIENCE: You can cover the same square footage by just buying four new machines and keeping one of the old 24-inch machines, and that decision would further support the decision of going ahead.

SPEAKER: We're beginning to add some alternatives here. In a sense, there is an opportunity cost involved here.

AUDIENCE: I figure that a total of 1,050 hours per man at $3.00 per hour is $3150 per man. Six men, $18,900 and 5 men, $15,750 for a savings of $2150 per year.

SPEAKER: Except for your subtraction error, the fact that you came up with $3150 is exactly what we have here.

AUDIENCE: Now I want to raise another factor; I can see where this is present time, but you've got six machines at $900 which have a life of three years. You're paying $5400 for three years or $1800 per year for equipment. If you go to five machines, $1200 a year, that's $6000 which gives you an equivalent cost of $3000 per year because they are good for only two years, so you have a $1200 deficit in terms of equipment costs. However, you save $3150, which offsets the deficit by almost $2000 rather than $450.

SPEAKER: This is so because the life cycles are not comparable.

I think we've got two problems here. If we look at this in terms of cycles, we've got a two-year cycle that we are considering first. Second, when we move into the next cycle, we would consider a six-year cycle, during which time we repurchase five $1200 mowers three times or six $900 mowers two times. In this case our present method cost $18,900 in labor and $1,800 in equipment per year or $20,700 per year. The proposed method costs $15,750 in labor and $3,000 in equipment or $18,750. Thus the proposed method saves $1,950 per year. This analysis has ignored present value and tax consideration.

However, the problem is concerned only with the next two years. We're assuming that funds are available, and we're recognizing that when I say a 10 percent discount rate, or a 10 percent interest rate, it's merely a way of providing information against which we can compare other alternatives. If this unit is responsible for an equipment budget, then the individual responsible has to decide what items have to be allocated out of that budget. This form of analysis may give him some information on the desirability of particular alternatives. He can then compare that with the desirability of all his other alternatives. In fact, there is a process, I guess you can call it an algorithm if we want to use the jargon, of comparing items in an equipment budget by looking at the return for each of those items. You could use a complete enumeration process or you could use a number of other algorithms such as the steepest assent algorithm. We're not going to have time to cover these processes, but the point is that if you reduce this information to a common basis where you have included all of the relevant costs, you are talking essentially about a trade-off concept. For example, if the equipment budget for Building and Grounds can be reduced to a common basis, you can identify which alternatives should be undertaken in a particular year.

AUDIENCE: I was just wondering how many alternatives should be given; is it five or six, or is there no limit?

SPEAKER: Theoretically there is no limit. But there is a practical limit simply in terms of the fact that it takes time to work with some of these alternatives. A decision like this is not one on which you can expend a great deal of effort because the amounts involved are relatively small. So the practical consideration is generally to limit the number to those for which we can, when we begin, expect a reasonable differential in the outcome of the alternatives.

AUDIENCE: How do you tell the Board of Education about this process, especially if you present numerous choices?

SPEAKER: Two choices is fairly typical. In fact, what I have ignored here are some of the political problems. As you say, how do you tell the Board that something like this is rational unless you have time to sit up there and lecture on it, and then you might not convince them. What we're after is the concept of sunk costs. In this instance the fact that those six machines are not fully amortized should be ignored. That is what is at stake. Let's leave it at that. If we have time later on, maybe we can come back to it. But I think there are some lessons to be learned in the other problems, and I hope we can get to the Page article.

PROBLEM 2

Let's move now to Problem Two. It should not take too much time because you are comparing similar alternatives here. Let's take about eight minutes on this problem.

Problem 2

The statistics labs have a request for an increase in their maintenance budget of $200 per month. They point out that this expenditure will save $40 per month in future equipment replacement. Assume the following table reflects all costs and benefits. Further assume the funds are available. Would you approve this request? If not, would you approve an alternative level of funding? If so, what amount?

Increase in Monthly Maintenance Expenditure	Reduction in Monthly Replacement Cost of Equipment
25	47.50
50	90.00
75	127.50
100	160.00
125	187.50
150	210.00
175	227.50
200	240.00
225	247.40
250	250.00

AUDIENCE: What was the monthly savings? Is it $40 as described above, or is it $240 as in the table?

SPEAKER: No, what he is saying here is that at the $200 level he is saving $240 monthly. It is costing him $200 to save $240, so that's a gain of $40. So the question is, would you approve this expenditure, or would you suggest an alternative level of funding?

AUDIENCE: Are you just trying to find the point of diminishing returns? Is this all you are after?

SPEAKER: Yes, depending upon how you define the point of diminishing returns.

AUDIENCE: That question is so obvious; how could you make such a request if they had such material available.

SPEAKER: Well, the point of diminishing returns may not be so obvious. The first thing you have to recognize is that when we move the maintenance expenditure of zero to $25, we generate a reduction in replacement cost of equipment (i.e., a benefit) of $47.50. The difference is a return of $22.50. When we move from $25 to $50, we generate $42.50 in additional savings or a net return for that particular expenditure of $17.50. So the point we are making is that as we move to each of these increments of expenditure, the net return diminishes until it becomes negative. See Figure 3 below for an improved display of what is at stake.

Figure 3

Increase in Monthly Maintenance Expenditure	Marginal Expenditure	Reduction in Monthly Replacement Cost of Equipment	Marginal Expenditure	Marginal Savings Minus Marginal Cost
25	25	47.50	47.50	22.50
50	25	90.00	42.50	17.50
75	25	127.50	37.50	12.50
100	25	160.00	32.50	7.50
125	25	187.50	27.50	2.50
150	25	210.00	22.50	-2.50
175	25	227.50	17.50	-7.50
200	25	240.00	12.50	-12.50
225	25	247.00	7.50	-17.50
250	25	250.00	2.50	-22.50

We would reject $200 per month in favor of a $125 increase. Now the point of diminishing returns can easily be seen. The highest return per dollar expended is at the $25 level. However, if we desire to obtain all of the returns possible (this assumes funds are available), then we would move to the point of an expenditure of $125 because at that point we generate a return of $2.50 for the expenditure of $100 to $125. As we move from $125 to $150 we begin to generate a loss. The concept is analogous to the profit maximizing concept in business. Now if you are in the public sphere, you have to be able to compare the kinds of returns which you can get for alternative inputs or funds, realizing that there are limitations on the amount of funds. If you spend $125, this assumes no limitation on the availability of funds. This is an illustration of incremental analysis or marginal analysis. We're looking at the return on the margin. The return on the margin from $100 to $125 is $2.50. As you move beyond that point, there is a negative return. Obviously one would never go beyond the $125 expenditure level.

AUDIENCE: In real life how do you obtain this information?

SPEAKER: There are tables which detail the impact on equipment life of certain kinds of maintenance. Now translating these into dollars may be more difficult, but it is not strictly "seat of the pants." There are such tables available, particularly from MAPI which is an institute which conducts, publishes, and sells equipment life studies. I don't know whether it is available on the type of equipment that might be in a statistics lab or not. I would expect so. This is the kind of equipment which is commonly used in education and in industry; thus, generating the input information is not a totally impossible task.

AUDIENCE: How do you know that you will actually realize this much savings?

SPEAKER: Of course past experience is a probability distribution. A single shows an average cost reduction. The conditions in any particular lab may not hold. There are a lot of factors that come into play. The problem does illustrate that there is in a sense an opportunity cost here. If you don't expend the first $25 on the maintenance activity, then you are going to incur a shorter life in your equipment; therefore, you've got a higher equipment budget rather than a higher maintenance budget. Obviously again, many of these things are useful when you have a large amount of equipment, whereas when you have small amounts they may not be worthwhile.

PROBLEM 3

Let's move to Problem Three. This problem will also allow us to discuss cost-benefit ratios which are frequently used in attempting to compare alternative expenditures. Let's take about five minutes with this one.

Problem 3

S.I.U. is contemplating designs for a central heating plant. Each design will last for 50 years. The only real question is a trade-off between the number of employees and successive designs which cost more initially but use less labor.

Design	Initial Cost (in 10,000's)	P.V. of Savings on Labor Costs (in 10,000's)
A	60	100
B	120	190
C	200	300
D	250	340

AUDIENCE: What is the heading on the last column?

SPEAKER: Prevent Value of Savings on Labor Costs. In other words, I've cranked in the present value concept here.

AUDIENCE: Are these annual savings costs?

SPEAKER: They're over the entire life.

The concept is really not difficult because if you'll look at your data, moving from the present system to Design A costs $60,000 and yields a benefit of $1,000,000. Therefore, the marginal return is $400,000. The difference between B and A is that we are increasing our expenditure by $600,000 for a return of $900,000. From B to C we're increasing our expenditure by $800,000 for a return of $1,000,000. The movement from C to D is an increase in expenditures of $500,000 for a return of $400,000. Moving from C to D is totally undesirable because the return on that is not sufficient to offset the cost. Design C is the optimum point, assuming total availability of funds. C is the point which will yield the best return because each increment of expenditure yields a positive return. The increment from present plant to Design A yields a return of $400,000. A to B yields a return of $300,000;

B to C yields a return of $300,000; C to D yields a net loss of $100,000. Sometimes the benefit-cost ratio is used. It is simply the marginal benefit divided by the marginal cost. This ratio must be greater than one if there is to be any net return for the total project. Some individuals have proposed that this will allow the decision maker to compare alternatives. It, however, ignores the level of expenditures. It also, of course, ignores the marginal concept. But it may allow the decision maker to begin a comparison. If you had a whole series of these kinds of alternatives, you could identify the benefit-cost ratio of each of these alternatives. See Figure 4 for the marginal and benefit-cost ratio data.

Figure 4

Design	Initial Cost (in 10,000's)	Marginal Cost	P.V. of Savings on Labor Costs
A	60	60	100
B	120	60	190
C	200	80	300
D	250	50	340

Design	Marginal Savings	Marginal Savings minus Marginal Cost	Benefit Cost Ratio
A	100	40	1.67
B	90	30	1.587
C	110	30	1.5
D	40	-10	1.36

AUDIENCE: Why do you say C instead of A since A has the larger cost-benefit ratio?

SPEAKER: The cost-benefit ratio is not directly useful for similar alternatives. Given sufficient funds marginal analysis has shown that Design C is optimal. We use the benefit-cost ratio by comparing the optimum point for each of the alternative types of decisions. When I say alternative decisions we could, for example, compare the decision to go ahead with this plant and the decision to go ahead with some other kind of equipment purchase. For example, we may find that the new alternative yields the benefit-cost ratio of 1.3. The power plant of Problem Three yields a benefit-cost ratio of 1.5. If you choose expenditures which yield highest benefit-cost ratio, you may approximate the greatest benefit out of your total available funds. You are first saying, "Considering this alone, what decision would I make if I had unlimited funds?" Then taking this decision you say, "For the university as a whole, I've got to identify what project I'm going to undertake." Conceivably you could use the highest benefit-cost ratio. That would be the simplest because you have identified the optimum for each particular decision and then compared each of the optimums. In this instance, it might be that because you chose the optimum for a particular decision and compared it with the optimum for another decision, the cut-off point for a desirable level of funding might be 1.55. Thus, you would eliminate the power plant as a total project. Whereas, if you submitted only Level A you would then have chosen that as a desirable project. It is possible to crank in all the information for analytical purposes, but it becomes difficult because of the fact that Design B is mutually exclusive of Designs A, C, and D.

SOME ADDITIONAL CONSIDERATIONS

The benefit-cost ratio will give you the alternatives to consider if they are not mutually exclusive. Simply take the highest benefit-cost ratio until you have utilized your existing funds. All I'm trying to demonstrate is that there are mechanisms, and this is the simplest mechanism, which would allow you to take the decisions generated in any particular program and compare them with other programs if you can reduce the information to this form. There are obviously some significant difficulties inherent in reducing it to this form. My objective is simply to demonstrate that we can reduce program suggestions, or reduce the competition for funding, to something which will give us an initial basis for discussion. Then we can begin to crank in our availability problems, political problems, problems with the board, and certain philosophical and ethical problems. So, what we are talking about is a methodology which I think gives us the first step towards eliminating some of the emotion in things like this. It simply gives a better basis from which to include or insert the judgment which we must, of necessity, use in the managerial decision-making process.

Although we will not have time to cover Problem Four, I will distribute the problem and answers for your future use.

Problem 4

A local industry has found that it cannot obtain adequately trained machine operators. It finds the applicants enter with two kinds of preparation: (1) no training, and (2) general machinists training. Thus, it is proposing the local high school offer a one-week intensive program on the use of the particular machines it uses. This course could be taught at night by local shop teachers. The local shop teachers have agreed to perform this instruction for $12 per hour. The class would meet for 15 hours (3 hours per day for 5 days). Cost of instruction materials, power to run the machines and other direct costs of the class are $200 in each week of the program.

The company has indicated that it will supply the machines and install them at no cost. The high school is in a new building which is not fully utilized. Thus, the space necessary to house the machines is available until increasing enrollment necessitates its use for other instructional purposes. Janitorial and machine maintenance costs are $200 in each week of the program. The machines occupy a room 30 x 40. The building costs were $50 per square foot. The school has an estimated 30 year life. Normal janitorial, building maintenance and utilities costs are $.05 per square foot of floor space per week.

The company offers to pay $600 for each class as long as eight or more students enroll. Assume that the school board will allow such an arrangement without prior approval as long as the monies received over the academic year can be expected to exceed the costs of the program. Assume theexpected enrollment will always be greater than or equal to eight. Should the program be undertaken? Show all calculations used to support this conclusion.

Problem 4-1

COST TO SCHOOL

VARIABLE COSTS	
Teacher's pay: 15 hrs. x $12/hr.	$180.00
Direct costs/wk.	200.00
Janitorial costs/wk.	200.00
Total Variable Costs	$580.00
FIXED COSTS:	
Normal janitorial and utility costs ($.05/sq.ft. x 1200 sq.ft./wk.)	$ 60.00
Depreciation Expenses (50/sq.ft. x 1200 sq.ft. ÷ 30/yr.= $2000/yr. ÷ 52 wk./yr.	38.46
Total Fixed Costs	$ 98.46
TOTAL COST PER WEEK	$678.46

This program should be undertaken only if no better use can be found for the space. The $600/wk. covers the variable cost and part of the overhead and should be taken in preference to letting the space stand idle.

The following factors may affect negatively the desirability of the undertaken program:

1. effect on efficiency
2. any fixed expenses which may be incurred outside of the immediate week
3. any future increase in costs generated by this program
4. any set up or take down costs that have not been recognized

Problem 4-2

Find the expected enrollment for the following probability distribution of enrollment.

Enrollment	Probability	Expected Value
<4	0	
5	.05	
6	.08	
7	.12	
8	.25	
9	.20	
10	.15	
11	.10	
12	.05	
>12	0	

Problem 4-2

Enrollment	Probability	Expected Value
4	0	0
5	.05	.25
6	.08	.48
7	.12	.84
8	.25	2.00
9	.20	1.80
10	.15	1.50
11	.10	1.10
12	.05	.60
13	0	0
	EXPECTED ENROLLMENT	8.57

TO FIND EXPECTED ENROLLMENT, USE $\sum_{i=1}^{n} \left[E_n \times p(E_n)\right]$

DISCUSSION OF PAGE ARTICLE

I do want to get into the Page article. Let me try to work through this step by step with you. I think what will probably happen is today I'll attempt to give you a feeling for what is included in the Page article and then tomorrow get back to an evaluation of the article.

THE PROGRAM AND ITS OBJECTIVES

What we have is an analysis of an official training program conducted in Massachusetts from 1958-61. There were 907 individuals who received some degree of training out of the program, 618 of which were men, 289 of which were women. The basic focal point of the training program was on barbers and beauticians. The primary skill which the program generated (over 50 percent of the trainees) was that of a barber or beautician. 18.5 percent of the enrollees were trained as draftsmen, technicians, office machine operators, and mechanics; 4.4 percent as secretaries, stenographers and typists; 4.6 percent as practical nurses. That gives you some indication of the orientation of the training program.

Page attempts to identify the expenditures for the program, the benefits of the program, and the means of ascertaining the net benefits which occurred as a result of the program if any. He also discusses the objectives of the Manpower Development and Training Act (MDTA), which provides the rationale for the program. In other words, the MDTA provides the basic objective of the program, which is to improve the utilization of unemployed and underemployed individuals.

COST FACTORS

Page begins with a discussion of the cost elements in the particular training program, and if you'll look at page 260, he identifies the total cost expended on the program by identifying certain elements of cost. He identifies the educational costs as simply the costs of putting on the program. He identifies these costs by assuming that the tuition expenses equal the educational costs. Educational costs include the wages and salaries of the personnel involved in the program as well as the amortization of the capital costs of the equipment used. Let's accept his conclusion that tuition costs do, in fact, equal the educational costs. This point may deserve some later questions.

Next he includes subsistence costs. The subsistence costs recognize the fact that individuals who are participating in the program receive certain transfer payments. That is to say, they receive a certain amount of money to be used for subsistence while participating in the program. The relevant subsistence costs are only those costs which are directly incurred as a result of this program. In fact, a rather large percentage of these individuals are already receiving either welfare payments or unemployment compensation. The rationale is that since they would normally be receiving these monies, whether they were in the program or not, then the only relevant subsistence costs are those which are borne directly by the program. This is entirely rational if the assumption that they would continue to receive welfare payments or unemployment compensation is rational.

He then goes on to talk about capital costs, referring basically to capital expenditures for the program per se. He shows no capital costs. Then he goes on and reports no supervision costs. Now, supervision costs recognize the cost to the agency. If this is sponsored by the labor department, then that agency is responsible for evaluating and approving the program. He says essentially that he does not know what the supervision costs are and that he is going to ignore the supervision costs. He thinks they are relatively small.

I want to comment briefly as an aside. In some management literature you might be exposed to the thought that if you can add this program utlilizing essentially unutilized time in the supervision agency, then there are no supervisory costs for the program. Obviously, I think that is an unrealistic assumption. There is no such thing as idle time. You have to recognize that if you add this program, the cost of adding the program ought to be recognized as an opportunity cost. You are going to pay less attention to some of your other programs. Therefore, one can expect a reduction in the effectiveness of the other programs. So the concept of utilizing so-called idle capacity is generally only partially useful.

AUDIENCE: You think it would be a mistake, then, to recognize work load trade-off. For instance, here you have a program reducing unemployment. How do you get the Welfare Department to reduce their staff in recognition of this program?

SPEAKER: Work load trade-offs and idle capacity are not really related. This program may eliminate some welfare activity. That may be a benefit if you can count on a staff reduction. However, this is a big if. Often this savings is illusory. There will be other examples where we will talk about reductions in the work force. In the first problem, the fact that we eliminated one employee in the grass-cutting task may not, in fact, mean that he is eliminated from the payroll. So those savings are contingent savings. They are contingent upon reduction of the actual payroll, or at least a transfer of the individuals who were on the mowing task to another kind of activity which is equally productive, and this is a rather tenuous assumption.

In the identification of labor savings it is rare that one can expect the total amount of potential savings to be realized. In fact, in industry typically nothing is eliminated immediately, but the activity is allowed to decline through normal attrition. Thus the analyst uses a factor applied to the savings which recognizes the attrition rate. This factor says we expect only a certain percentage of the savings potential to be realized. So the analyst identifies potential savings and the factor which reduces the earnings. It may be that only 90 percent or 80 percent or 60 percent or 50 percent of the potential savings are considered actual savings. But there is no mechanism that I know of to force other agencies to allow a different agency to realize their potential savings. If, though, what we are talking about during this whole session has any meaning, what is done in this retraining program does affect the welfare system and the two cannot be ignored. Basically it is a matter of developing cooperation. I don't have any particularly meaningful insights on that kind of a process.

I think one of the problems inherent in this thing is how you identify the supervision costs. If you take people off one type of supervisory activity and put them on another type of supervisory activity, how do you identify the supervision costs? Again, a typical process is simply to look at the salary costs which represent the dollars which can be attributed to the supervision. However, this process ignores the opportunity cost which is the relevant cost. For example, if a man is removed from supervising a program costing $250,000 and its effectiveness declines by 10 percent, then the supervisory costs exceed $25,000 although his salary may be only $10,000.

Having identified these four cost elements Page merely sums them to get total costs. Page has ignored the fact that we are taking these individuals potentially out of the labor force by putting them in this particular training activity. They lose the opportunity to become employed while they are engaged in training. At the same time we should recognize that in conducting the cost-benefit analysis we should be looking at the analysis from a social standpoint. Thus, if we assume that there is a large mass of unemployed individuals, then by training a small group some members of the group may forego the opportunity to become employed during the training period, but others in the mass will have an increased chance of being employed. Therefore, there are no opportunity costs. We are saying to the individual there are clearly opportunity costs, to society there may not be any opportunity costs. It is difficult for me to agree that there will be no social opportunity costs.

BENEFIT FACTORS

Having identified the costs of the program, Page goes on to identify its benefits. These benefits are identified by focusing on the increased income earned by the individuals completing training.

Now I should warn you that Page is not a mathematician, that his use of symbols sometimes leaves something to be desired. It doesn't particularly aid the translation. What he is saying is, "Let's take these individuals, these 907 individuals, and identify the differential income attributable to training." If we say individual A is earning $3,000 a year prior to re-training and is earning $4,000 a year after re-training, the potential benefit is the $1,000 per year over this remaining working life.

It is important to recognize that he is focusing on the benefit to society not the individual. Thus, it is gross income not after-tax income that is relevant. Taxes are merely a mechanism for society to redistribute its productivity and should thus be included in the benefits. In other words, Page begins with the assumption that people so trained may move into these employment opportunities without displacing anyone else. Thus, as these people move into the work force there is, in fact, an increase in productivity.

In reality it seems reasonable to expect that the truth lies somewhere between the extremes. There is probably some displacement of current workers and some new productivity generated.

He goes through a big manipulation to identify the total of the increase in income for all of the individuals who completed training and found appropriate employment. Notice the qualification, "who completed training and found appropriate employment." He says 582 of original 907 trainees completed the approved training courses and found employment. But only 438 were employed in the field for which they were trained at the time the survey was taken.

AUDIENCE: Four hundred and some didn't get employed in the area of training. Is that because they weren't quite as good at the end of the training period or because of other opportunities?

SPEAKER: He didn't really say.

AUDIENCE: Shouldn't it make a difference whether the 150 who completed training but didn't get jobs failed because of lack of openings or because they didn't obtain the necessary skills?

SPEAKER: Yes and no. It should make no difference in measuring potential benefits. Since I disagree with him on the method of measuring, I'll discuss this shortly. However, if some failed to get jobs with the necessary skills, then the likelihood that displacement has taken place is high. Consequently, the benefits are probably overstated. What he said was: I assume the basic reason for the increase in income is due to the skills which are imparted. Those who were not employed in this particular type of activity will be ignored. This is in my opinion a mistake. He obviously ought to consider them. From the standpoint of evaluating the program, it is, in essence, results that count. He is implying that of those 438 (about half of the group who started the program) the other hald did not receive any change in their income. They went neither up nor down as a result of the training. He does not demonstrate this; he ignores this fact. In fact, he never even states it as an assumption, which is one of the major errors in his presentation. So you cannot ignore the fact that you started with a group of 907 and somehow you only consider 438.

AUDIENCE: I couldn't help but think from your opening remark that in your department you have people who are trained for something else.

SPEAKER: That's true. In fact they may be employed in an alternative activity which may even generate a greater return than the particular productivity for which they were trained. It is an interesting question though to debate with the audience whether we can expect that the ignored group would have had the same income, a higher income, or a lower income. In fact, it is also an interesting question to debate with the audience whether we can expect the income differential to remain the same over the life of the individual, to go up, or to go down. We can probably get the entire range of opinions on the matter.

AUDIENCE: Are you saying that figures never lie, but liars figure?

SPEAKER: Something like that. Again what we are trying to do is to get a base for which we can at least identify that the training makes the difference. That's the point which is at issue here.

AUDIENCE: It occurred to me that at least some number of those who have had partial training in the series will derive absolutely no benefit.

SPEAKER: I would argue that the nature of what is going to happen in the future, in terms of income increase or income decline, is going to be strongly dependent not only upon immediate job skills but also, if I may use the term, on job retention skills, These are really social skills and basic educational skills. I would argue that a rational training program, if it is going to expect continuation of the income increase, is going to have to incorporate more than simply vocational skills. That's one man's opinion. In order to answer the question of whether I would expect the income in the future to decline or remain the same or increase, I would ask questions that would give me a deeper insight into the nature of the program. These are the kinds of questions that must be raised to properly appraise this program.

You will recall that Page defines income in the social sense; therefore, he ignores taxes but he does not ignore transfer payments. Transfer payments are welare payments or unemployment compensation. He takes these out of the before-training income and out of the after-training income. So when he is talking about benefits he is talking about the benefit which recognized social productivity. Transfer payments do not recognize social productivity as we have indicated.

Now he says based on these assumptions, we have a benefit in the first year of $443,488. He continues by recognizing that maybe we can't attribute all of this to the training program. We know that everyone in society has been receiving the benefit of the overall increase in productivity plus inflationary increases.

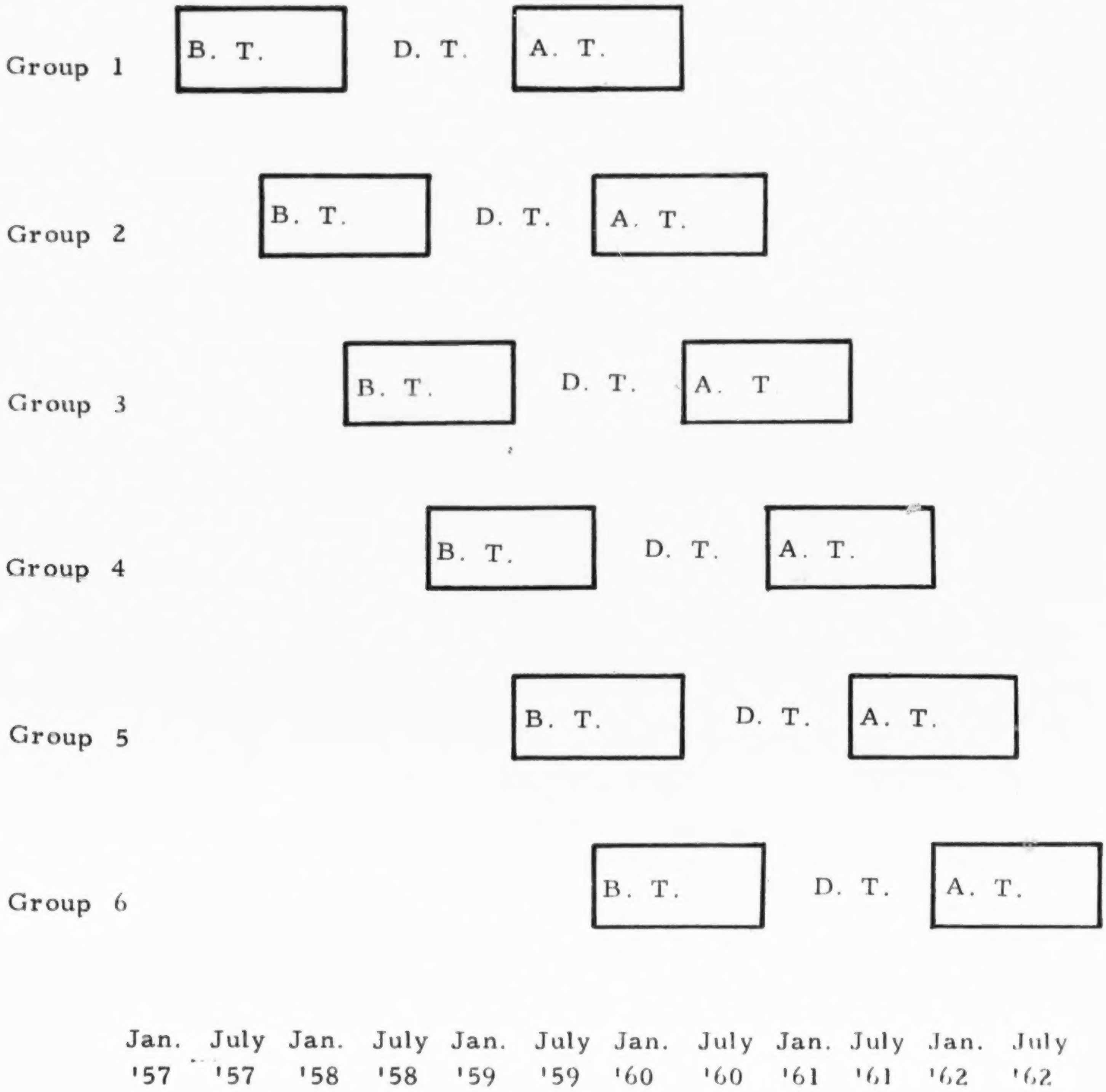
Let us illustrate what is at stake. Since I am drawing inferences solely from the article, my understanding of the facts may be erroneous. For simplicity assume the training program is six months and begins on January 1 or July 1 and spans the period July 1, 1958, through June 30, 1961. Further assume there were six equal groups of trainees. The following chart will graphically portray this. (See Figure 5)

For example, Group 1 had its income measured before training from July 1, 1957, to July 1, 1958. It took training from July 1, 1958, to January 1, 1959, through January 1, 1960. Assume that the before-training income averaged $3,000 and after-training income averaged $4,000. However, if the average income of all workers increased by 10 percent, then all of the $1,000 increase cannot be attributed to the training program.

What Page does is to develop a questionnaire which he sends to some 104 individuals whom he has culled out of the United States Employment Service records. The group characteristics are presumable the same on six particular factors as the group which is undergoing training. He mails a questionnaire to them to identify their income prior to the training period and their income after the training period. Then he identifies what kinds of changes are taking place in society. If, for example, the average was $3,000 before the training period and $3,300 after the training period, then he begins to recognize there has been an increase in income just as a result of normal social factors. If there has been a 10 percent increase in income, then only 90 percent of the income can be attributed to the training program. He, therefore, reduces the income attributable to the training program to this particular figure. He is determining what proportion

Figure 5

TIME SPAN FOR TRAINING PROGRAMS


Group 1
B. T.
D. T.
A. T.
Group 2
B. T.
D. T.
A. T.
Group 3
B. T.
D. T.
A. T.
Group 4
B. T.
D. T.
A. T.
Group 5
B. T.
D. T.
A. T.
Group 6
B. T.
D. T.
A. T.
Jan. '57
July '57
Jan. '58
July '58
Jan. '59
July '59
Jan. '60
July '60
Jan. '61
July '61
Jan. '62
July '62

B. T. is the time before training when income was measured.

D. T. is the time during training.

A.T. is the time after training when income was measured.

of the income can be attributable to that figure. Again, in my opinion this is wrong. If the average trainee shows income of $3,000 per year before training and $4,000 following training (ignoring transfer payments), he has generated a potential increase of $1,000. Page says that only 9(percent or $900 per trainee can be attributed to the training. However, the average trainee could expect $3,300 without training, so only $700 per trainee can be attributed to the training. Then he says what we have to do is to recognize the stream of income over time. He is saying that the income which is received in the first year is the same as the income which will be received in each of the subsequent years. If it's a $500 average increase in the first year, he is expecting it to be the same in all subsequent years. Therefore, he has to identify the present value of that stream of income. We have already talked about the present value concept. Using the 10 percent rate, if our stream of income was received for only two years, then we sum the present value factors and multiply the sum by the income. If the difference is $500, the value of this stream of income two years hence is $1.735 times $500. The present value of the $1,000 is 1.735 times the $500, which is less than $1,000. He uses the present value factor which is 9.644 for a period of 35 years and, therefore, identifies the fact that the total value of the benefits is in the neighborhood of $3,900,000. He then comes up with the $3,300,000 as the approximate net benefit of this program, subject to a number of questions which we will discuss tomorrow.

Incidentally, I would like to pass out this material which is another item I hope we can discuss tomorrow. It represents a program proposal for a doctoral program in Thermal Nuclear Physics, or something like that, which I would like us to discuss from the standpoint of how you would judge it in light of the material which I have been presenting to you. I think we in education need to think along these lines when we submit program proposals.

SUMMARY OF PAGE ARTICLE

Page Article major weaknesses:

1. No opportunity costs. Estimate is 582 trainees for six months at $1425 is $829,350, plus $325 for 3 months at $712 is $221,900, for a total potential

opportunity cost of $1,051,250. Let us assume 20 percent of this potential loss occurred. Thus the estimated opportunity cost is $210,250.

2. Supervision costs. Let us assume these are so nominal as to be ignored.

3. Ignoring the 144 who completed training, but who did not work in the field for which trained. Since the increase for these employed averaged $970, let us assume that subsequent analysis discloses that their after-training income went up $592 (or 20.8%). Since 10.4 ÷ 20.8 = .5, $296 is attributable to a training or a total potential benefit of $296(144) = $41,544 per year.

4. Overstating the benefits by counting 91.3 percent of the potential. Since the increase for the control group was 10.4 percent and the increase for the experimental group was 34.2 percent, 10.4 ÷ 34.2 = 30.4% of the increase is due to normal conditions. Thus only 96.6 percent of the $443,488 is attributable to the training.

5. Ignoring the 325 who did not complete the training. Let us assume that further analysis discloses that their after-training income went up by 10.4 percent. Since this is the same as the control group, we may ignore this group. Please note that they can be ignored only after proper analysis or by explicitly stating the assumption which allows them to be ignored.

6. He assumes no displacement. The fact that 144 graduates didn't get placed would imply some displacement. Let us assume after analysis, a 30 percent displacement factor. Thus only 70 percent of the potential benefits are realized. Since potential benefits are $308,668 plus $41,544 or $349,202, then actual benefits are $349,202 (.70) or $244,441.

7. He assumes that the income differential will be the same over the remaining work life. This involves questions of inflation and real income changes as well as skill maintenance questions.

> It is possible that mechanical innovations will eliminate the need for barbers and beauticians and their skills may be obsolete. My guess would be that the men will maintain the relative differential but that women will not. Since about 30 percent of the initial group were women, it is logical to assume a similar percent of the graduates are women. Thus the 35 year benefits must be reduced. However, it is to be expected that the women will work for the first few years when the benefits are the highest. Let us use a present value factor of 9.0 rather than 9.644 to correct for this. Thus gross benefits are $244,441(9) = $2,199.969. Net benefits are then $2,200,000 less ($633,359 + $210,250) = $1,351,400. Although this is only 40 percent of the figure Page comes up with, it still shows a very high return. The benefit-cost ratio is about 3.9.

This exercise is intended to demonstrate the use of cost-benefit analysis on educationally oriented programs. As with all analysis there are crucial assumptions which must be recognized and resolved to the satisfaction of the decision maker.

From a decision-making standpoint the displacement factor is crucial. The displacement factor is bound to increase as the number of graduates increases. Thus, the apparent success of the program does not necessarily signal the desirability of continuing the program.

DISCUSSION OF THE HAMELMAN ARTICLE

An unpublished paper entitled "Planning and Analysis for Higher Education: Promises and Pitfalls" by Paul W. Hamelman is used to show an improved method of obtaining cost data for specific programs at large universities. If we are to look at the desirability of undertaking new programs or continuing old programs, we need accurate cost data. Professor Hamelman shows a method for identifying the "joint" direct costs of educating a student in a specific program. His data (see Appendix II, Table 2) show that the cost per credit hour varies from $13.16 for business for $40.97 per for engineering. Since students take courses from a wide variety of courses, the cost of educating an engineer would be grossly overstated if we multiplied his hours by $40.97. By the same token the costs of educating a business student would be understated if we multiplied his hours by $13.16. Hamelman has, in fact, identified the cost per hor by major in the right-hand column. This cost varies from $16.29 to $29.27. Table 2 is self-explanatory. For example, the agriculture student averages 7.21 credit hours of agriculture per semester, .7 hours of biology, 1.74 of chemistry, and so on. Since $150,000 in resources are allocated to agriculture and it generates 5139 credit hours, its cost per hour is $29.29. Thus the cost of agriculture instruction provided the average agriculture student is 7.21($29.29) = $211.18. Added to this is the cost of biology instruction provided the average agriculture student which is .7($38.44) = $26.91 plus cost of instruction provided by other departments to the average agriculture student.

This data is subject to four major deficiencies:

1. Only direct costs are reflected; thus costs of space, libraries, etc., are ignored.

2. The costs per hour for each unit are an overall average, and the so-called joint costs reflect this average. For example, English performs a significant service role, whereas engineering performs virtually no service role. It is to be expected that the English Departments' cost for service courses are lower than their cost for English majors. Thus the cost of the English major is apt to be understated and all other majors overstated. This could be partially overcome by determining costs per credit hour by level (i.e., lower division, upper division, and graduates).

3. This includes all salary costs regardless of assignment. Thus a unit heavily engaged in unfunded research generates a high cost per credit hour. This could be corrected by identifying the assignment.

4. The cost per semester reflects the cost of a student who enters a program as a freshman and eventually graduates. Those who drop out or switch majors are ignored.

In table 3 Hamelman attempts to wrestle with items 2 and 3 above. Apparently assignment data was not available, so he made some assumption about assignments. The addendum to Hamelman's article demonstrates how he might determine the values for Case II (the business student).. One point that is not clear is the effect of item (c) under the Statement of Assumptions, on the table. I have included the cost of student advising, committee work, etc.

The reason that the costs in Case I are lower is because the number of faculty and salary is the same as in Case II, but 1/2 of the full professors' time and 1/3 of the associate professors' time are assumed to be chargeable to research.

There is nothing in this presentation that is supposed to be particularly difficult. It is simply a demonstration of one rather simplistic procedure which at least moves us into a position to identify not only the cost of educating a student across the board but also the cost of educating the student in the lower division, the upper division, and the graduate division for any particular major. If you look at those figures, it would appear as though some of them are way out of line and they may raise some questions. The factors which caused that are something that I am nor familiar with since I am not familiar with West Virginia University.

EVALUATING A PROGRAM PROPOSAL

We discussed the concept of cost benefit analysis and the concept of PPBS, and I want now to move us in the direction of the evaluation of educational programs I have distributed. Now obviously I think as a starting point there is some relevance, and I suggested that we look at the proposal for the establishment of the doctoral program in molecular science at SIU as an example of a doctoral program that has been approved through University channels; it is currently functioning. The document was about one inch thick, but most of it was course descriptions and faculty resumes. Other than that this is what was submitted as the basic justification for the program.

Now let's just kind of open up this discussion. What is your general overall impression? What information would you seek if you were sitting in judgment on this, ignoring the question of whether the staff is qualified to handle a doctoral program or the question of whether there is adequate course work? If the staff is there the course work is obviously going to be there, so there is no educational criterion that must be considered in here. The real question is, is the program one to which you feel we should devote the requested level of additional funds. Now we also might want to question the projection technique on enrollment and the projection technique on additional funds. Anyone want to start the discussion?

AUDIENCE: One thing, academic departments asking for new programs don't raise the question of the library. They just seem to feel the library fund is something that is just going to materialize out of the blue.

SPEAKER: I would agree. There is a cost element.

AUDIENCE: Is there an assumption here that there will be no increased individuals' salaries over this seven or eight year period?

SPEAKER: I found that somewhat hard to figure out when I looked at the '68-'69, '74-'75 budget because he talked about a staff increase from 40 to 60 or 50 percent and a budget increase of from $300,000 to $450,000 or 50 percent. Are we getting lower qualified people so that we can raise the salary of the other people, or does the '74-'75 budget ignore salary increases? I don't know; I wasn't there.

AUDIENCE: What's the excuse of tooling up for at least $75,000 in each year?

SPEAKER: They ought to be well tooled up anyway. They are talking about a rather broad spectrum area, an area which requires obviously an extensive major equipment cost. I'm still not sure I recognize the difference between major equipment and tool-up cost. I suspect there may be a fine breakdown between the two which I would use as major equipment costs. There is no evidence in here of the nature of these expenditures so that the person evaluating the proposal can evaluate the reasonableness of this forecast. So we have no anticipation of increased salary costs; we have no support for major equipment for tool-up cost in terms of what they are going to buy.

Looking at the government's experience with the high speed transport SST and C5A and other fancy pieces of equipment, the projections on these costs are very important. The government rarely forecasts their costs very accurately in this particular sphere. Frequently, it is on the order of about 200 percent higher than the initial forecasted cost, and the federal government is considerably more sophisticated in this kind of forecasting procedure. Any further comments?

AUDIENCE: One rather obvious question: Why raise the non-academic personnel allocation in this period of time 140 percent and the academic personnel only 50 percent?

SPEAKER: I suspect they might have a valid answer for that, but since no justification is provided, the question cannot be answered.

AUDIENCE: Where is the cost of office and laboratory space?

SPEAKER: It does not appear to be included. Since overhead charges on government contracts are 55 percent of personnel costs, overhead would be estimated at 55 percent of $325,000 in '68-'69 and 55 percent of $510,000 in '74-'75.

AUDIENCE: How many other similar programs are there?

SPEAKER: I don't know. Again, there is no information. I think the lack of demand information is the major drawback. They were fortunate in that respect. Now the requirements are such that at least there has to be a forecast of demand for the State of Illinois and an indication of other Illinois programs that are comparable as well as a forecast of the numbers of students in your program and their program. That is the beginning step. I would say it is only the beginning because you really need information on the entire country. It is foolish to assume that molecular science programs in the State of Illinois are independent of other states.

AUDIENCE: When you said this went through all the channels, you mean this was approved by the staff of the Higher Board of Education as well? And with just this much information?

SPEAKER: Well, there were hearings on it. But this is what went forward to the Board and presumable with no modification. Now of course we don't know what went on in the hearing.

I think if I had approved the proposal I would want to have the records of the hearings in the files. This report is all the Graduate School at Carbondale has in the files on the approval for this program.

AUDIENCE: What was the job market for the two 1968 graduates?

SPEAKER: I don't know. That is obviously a relevant item that could be included here.

AUDIENCE: Isn't there another relevant item, and that is are there other programs that would be more beneficial to the students which this university serves.

SPEAKER: The question here is essentially a trade-off question. He is saying that this molecular science program is a program which is within the objectives of the university. Is it the best program which can be offered to the body to which we are providing this service? What kind of public considerations went into the investigation? I think this kind of question could be raised for almost any proposal that comes forward.

AUDIENCE: I think another thing, too, is that in the University we talk about the systems approach being a series of alternatives. It might be better if we spend our money on a course Doctor's degree in computer science.

SPEAKER: Right.

AUDIENCE: It is hard to believe that this program was actually approved. First, there is an assumption that there will be no dropouts during the program. The third-year students are carried over to the next year in their entirety. The cost per graduate in '74-'75 is about $50,000 a student, and the cost of all 90 students in the program is about $8,500 apiece.

SPEAKER: This is the cost when the program is fully operating, and I suspect it is not abnormal. It does, however, produce an equal number of master's students as a side benefit. The actual cost per graduate prior to '74-'75 is somewhat higher. But the public does not know what it costs to educate many of these doctoral students. There are some start-up costs. Start-up costs in any program are inevitable. You have to look at the per student cost and then amortize the start-up cost over some life cycle on the program.

AUDIENCE: We are screaming because the state law mandates that we have to have one teacher for every ten nursing candidates, and they are projecting some kind of involvement of two faculty members for every three students.

SPEAKER: It is difficult again here to identify the breakdown of time distribution, which is, I think, one of the errors in the proposal. We talk about 40 to 60 faculty members, and obviously they are not talking about 40 or 60 faculty members for this program. But they ought to identify what the specific faculty input would be for this program.

There is obviously lots of academic pressure that moves units in the direction of advanced studies. People must really begin to ask themselves, in a true academic sense, what they should be doing. Again, I assure you that dollars is not and should not be the measure of the educational program. This is really what PPBS says. It says if you have a molecular science program, you ought to be able at least to compare that program with a series of programs knowing what their costs are. Then if we wish to we can begin with the assumption that their benefits are identical, or if you want to modify that and say this particular program may generate X amount of income benefits. But maybe a program in philosophy is going to generate a considerably greater social benefit. We then at least begin to narrow down our areas of disagreement to something which I think is a real gutsy question. Again I think this is really the thrust of the kind of tools which we are trying to provide you now.

AUDIENCE: Were there no comparable situations with historical data that they looked at to try this?

SPEAKER: As far as I know, none. I wouldn't fault them because it is common. We have to say that if you are going to submit a program for approval, you have to go through the process of identifying where the students' forecasts are coming from, recognizing all the costs that are included in the program so you can identify the validity of your cost forecasts and include all of the costs.

AUDIENCE: There is nothing in here that suggests what this does in the master's program or what assumption there is that the master's program is adequate. There is a statement to the effect they think that it will increase it.

SPEAKER: Yes, again you have to ascertain more precisely what the impact is. It may well result in a decline in the effectiveness of the master's program as a result of this program. It may alternatively be an increase in the effectiveness and desirability of that program, too. In fact, I think most educators would argue that the doctoral program enhances the master's degree program. I'm not sure that's a totally tenable position, but it is a very commonly argues position, particularly if you are seeking a doctoral program.

AUDIENCE: There is a whole area of research that has to go into this that hasn't been touched, and that is Market Analysis. You don't start a program until you know what is the need for the product. Others are offering the same program and what are the employment potentials? Who makes the subjective analysis and determines an answer.

SPEAKER: This is of course an advantage that private industry has. Rarely does a single individual have the decision-making power in the public sphere. Generally it is more than one individual who has to make at least a recommendation to the individual who makes the ultimate decision. There is a greater degree of restrictiveness, I think, in the kinds of decisions that can be made in a public sphere. Some of this may be perceived restrictiveness rather than actual restrictiveness, but it is there nevertheless, and I think it should be there. There are procedures and techniques which have been and which are being developed, particularly by the School of Administration at Case-Western Reserve in Cleveland, which are aimed at both logical and valid methods of seeking group decisions. That group has done a good deal of research on this whole area of group decision making which has a rather interesting level of surface validity.

In fact, I think Sam was involved in some of this using the DELFI technique in projecting the nature of education in the year 2000. The mechanics of the DELFI technique involve a process of utilizing individual inputs to develop a group decision. I think you would be surprised at the degree of agreement you can reach on many of these factors once they are reduced to the level that I am suggesting.

AUDIENCE: Was there an alternative to the Molecular Science program, or did you have a gungho professor that hears something that needs to be done and somebody says he has the inside track. I won't even submit mine.

SPEAKER: There were other programs, but they were not considered as competing programs. They were considered as programs for which one simply says the program stands by itself. There was no trade-off consideration; the program was essentially presumed to stand by itself without regard to whatever else was considered. This is kind of an interesting problem because what has happened in some instances has been approval of programs but no funding for those programs. That is where somebody begins to say, look, I don't mind saying the program is fine, but I'm not going to put any dollars in back of the program. I don't know where this program stands dollarwise at this point in time. I do know that the School of Business had a funding cutback in one of its programs and we were told that all other new programs were cut back an equal percentage. Obviously these programs don't stand independently. They are very dependent. I think it is also a mistake because the cost of a program if you have only a few students is going to be fantastically higher than if you have a larger number of students. So if you equally cut back each program, it seems to be increasing the cost per student across the board.

AUDIENCE: What about alternatives within state institutions, i.e., the thought of not offering it here because it is already offered in the state.

SPEAKER: That is the current requirement, but this proposal got through before the Higher Board said they were going to consider alternatives between institutions.

It should be recognized that there are many benefits that are difficult to quantify. See, for example, the second paragraph of P. 4 and the first paragraph on p. 5.

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Retraining under the Manpower Development Act: A Cost-Benefit Analysis

by **DAVID A. PAGE**

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STUDIES OF GOVERNMENT FINANCE

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RETRAINING UNDER THE MANPOWER DEVELOPMENT ACT: A COST-BENEFIT ANALYSIS

David A. Page[*]

INTRODUCTION

The need for training of the structurally unemployed has become widely recognized and publicized. Virtually every comprehensive study of the unemployment problem conducted in recent years has identified training, or retraining, as a partial remedy. These studies range from reports of the Joint Economic Committee and The Committee for Economic Development in its report on Depressed Areas in 1961, to general articles in newpapers and magazines.

In recent years, Congress has enacted several laws designed to provide workers with new skills, including the Free Trade Act, the Area Redevelopment Act, and the Manpower Development Act. It is against the backdrop of general recognition of widespread need that Congress has given nearly unanimous, bipartisan support to these programs.

The purpose of this paper is to analyze the attempt to maintain a higher level of employment in the United States by retraining those who, for whatever reasons, have become unemployed. Data for the analysis were drawn from a statistical summary of a population of 907 retrainees assisted in Massachusetts between 1958 and 1961.[1] The population was comprised of 618 men and 289 women from all areas of Massachusetts, who sought retraining as a means of improving the steadiness of their employment, and increasing their weekly salary. The program took place under Massachusetts law, but an economic analysis of this experience should provide insight into the costs and benefits likely to occur under the Manpower Development Act.

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[*] Department of City and Regional Planning, Harvard University. The author is indebted to Edwin C. Gooding of the Federal Reserve Bank of Boston for his aid in providing data for this paper; and Professor Otto Eckstein of Harvard University for his generous assistance and advice. The paper was prepared as part of the Public Expenditures Program, sponsored by the Committee on Government Finance of the Brookings Institution.

[1] The summary was produced by a joint research project of the Federal Reserve Bank of Boston and the Massachusetts Division of Employment Security under the direction of Edwin C. Gooding, and entitled: *The Massachusetts Retraining Program*. Supplemental data were obtained through interviews.

OBJECTIVES OF THE MANPOWER DEVELOPMENT ACT

The Manpower Development Act (MDA) has as its general objective the retraining of underemployed and unemployed workers for necessary skills, so that they may be more gainfully employed citizens and make a greater contribution to the national economy.[2] In economic parlance this would normally be called an "efficiency" objective.[3]

The Act is based on the assumption that there are large numbers of jobs waiting to be filled if workers with obsolete skills can somehow be retrained to qualify for them. It implies that vocational training for unemployed workers is a more satisfactory way to meet one aspect of the unemployment problem on a long range basis than simply providing relief in the form of unemployment compensation and welfare payments.

Writers of the Act suggest that the more rapidly our economy advances the more rapidly skills become obsolete. Despite the fact that training is already being carried on by public educational authorities assisted by the federal government's vocational education program and by private schools, in the minds of the legislators it was clear that

> combined federal, state, local and private efforts fall far short of the total need, and that without an intensive, nationwide program to provide opportunities for retraining tens of thousands of worthy men and women will never be able to obtain the skills which will enable them to be self-supporting and to make their maximum contribution to the nation's productivity.[4]

The MDA established a program to fill this need. It directed the Secretary of Labor to take the initiative in determining the training needs of the nation in consultation with local authorities, and it provided funds for establishing training programs primarily through existing public educational authorities. It also authorized the payment of subsistence allowances to trainees. In the interests of public information it requires the Secretary of Labor to report annually on the nation's manpower requirements and resources, and the President to report annually to the Congress.

COSTS AND BENEFITS OF RETRAINING

In order to have some sense of what may be expected of the Manpower Development Act and its implementation, it should prove useful to examine the costs incurred and benefits derived from retraining the 907 men and women involved in the case study. Taking as the objective economic efficiency, the net benefits accruing to society may be measured in terms of this objective.

Capital costs for retraining under the MDA will tend to be negligible, since the Act requires the Secretary of Health, Education and Welfare to provide training facilities through agreements with the states and states' vocational agencies. The states in turn are to provide for such training through existing public education agencies or institutions. If state facilities are inadequate or inappropriate to this purpose arrangements may be made with private educational and training organizations. Funds are, at the present time, intended only to make minor repairs deemed necessary for adequate training. In the Massachusetts case no capital costs were incurred that were attributable to the training program.

Costs of operations and maintenance can conveniently be divided into three classifications: (1) costs of education; (2) costs of subsistence allowances, including transportation during retraining; and (3) costs of supervision. Costs of supervision have to be estimated since the Act is to be administered through existing structures of government. Except where additional governmental expenses have been incurred as a result of the training program, the administrative opportunity cost may be considered negligible.

Cost of education, or "tuition" includes such items as rental on equipment and facilities and instruction. There are few economic questions involved here, the main problem being simply one of measurement. Since tuition was actually charged the Massachusetts trainees, real values may be used in the analysis.

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[2] "Manpower Development and Training Act of 1962," *U.S. Code Congressional and Administrative News*, West Co., St. Paul, Minn., April, 1962, pp. 439-450, 474-502.

[3] The question naturally arises as to whether redistribution of income is an objective of the MDA. The wording of the Act indicates that redistribution is only incidental, and not meant to be a major objective of the program. However, in so far as new workers are placed in the workforce redistribution is inevitable in the Lorenzian sense. A moderate amount of redistribution also occurs as the result of paying subsistence allowances, and other costs of retraining, with public funds.

[4] *U.S. Code Congressional and Administration News*, "Legislative History: Manpower Development Act," West Publishing Company, 1962, pp. 474, 475.

Subsistence costs represent a somewhat more complex problem. The MDA provides for subsistence allowances for trainees and their families totaling not more than the amount qualified for under the respective state unemployment compensation allowances. Moreover, these allowances are provided only if funds are not available through unemployment compensation. Therefore, only the differential amount should be charged to the retraining program, since presumably this cost would be incurred regardless of the existence of a training program. In the Massachusetts case, subsistence chargeable to retraining amounted to approximately 83 per cent of total subsistence during the training period. The Act provides for subsistence for a period not to exceed 52 weeks. Anyone undergoing training in excess of one year would be forced to procure funds from other sources.

Both types of costs may be incurred in on-the-job training. The Act provides for supplementary education as well as differential subsistence payments to on-the-job trainees.

Since all costs may be expected to accrue during the training period, there is no need to reduce them to present value, and the total cost equation may be written as

$$C_T = C_E + C_M + C_K + C_S$$

where:

C_T = total costs
C_E = educational costs
C_M = subsistence costs
C_K = capital costs
C_S = supervision

Using the costs incurred in the present case, total costs of retraining may be computed for the group.

Gross benefits to be derived from retraining in terms of our efficiency objective may be measured as the change in individual income streams. Denoting b_i as the benefit of the i^{th} individual, y_{1i} as the income of the i^{th} individual with retraining, and y_{0i} as the income of the i^{th} individual without retraining, we may write

$$\triangle b_i = y_{1i} - y_{0i},$$

and summing over the group of all retrainees, we obtain

$$\sum_{i=1}^{n} \triangle b_i = \sum_{i=1}^{n} (y_{1i} - y_{0i}).$$

Since the average group income with and without retraining will be used rather than individual gains (or losses), the benefit equation may be rewritten as

$$B = N(\bar{y}_1 - \bar{y}_0)$$

where B is total benefit for the group, and N is the number of retrainees. Or, for the sake of simplicity,

$$B = Y_1 - Y_0$$

where the Y's denote total group income with and without retraining.

In this regard, three refinements must be made. First, an individual's income with and without retraining may include transfer payments from unemployment compensation and welfare. Since only earned income may be taken as a measure of productivity, transfer payments should be deducted from total

EXHIBIT I

Costs of Retraining

Tuition	\$ 567.10 (average)
Subsistence during Retraining	143,000.00 (total)
1959 Employment Compensation	24,000.00
Net Subsistence during Retraining	119,000.00
Supervisory	*
Travel	†
Number Trained	907

$$\begin{aligned} C_T &= C_E + C_M + C_K + C_S \\ &= 907(\$567.10) + \$119,000 + 0 + 0 \\ &= \$633,359.00 \end{aligned}$$

* Supervisory expenses were of course not zero but the program was administered through regular machinery and no estimates were available.

† Travel allowances were negligible in this case study.

income to determine net gains to an efficiency objective.[5] Denoting total income with and without retraining as Y_{t_1} and Y_{t_0}, and total transfer payments with and without retraining as Y_{p_1} and Y_{p_0}, the benefit equation may be rewritten as

$$B = (Y_{t_1} - Y_{p_1}) - (Y_{t_0} - Y_{p_0}).$$

And, using the statistical summaries of the information supplied by the trainees, the gross benefits may be calculated.

EXHIBIT II

Gross Benefits to Retraining

Gross Benefits	
Total income with retraining	$ 3,823 (average)
Total income without retraining	2,847
Increase	976
Per cent increase	34.2%
Transfer payments without retraining	24,000 (total)
Transfer payments with retraining	8,000
Decrease	16,000
Per cent decrease	66.7%
Number of trainees who found jobs using training skills	438

$$B = (Y_{t_1} - Y_{p_1}) - (Y_{t_0} - Y_{p_0})$$
$$B = [(3823)(438) - 8000] - [(2847)(438) - 24{,}000]$$
$$= 443{,}488$$

Five hundred and eighty-two of the original 907 trainees completed the approved training courses and found employment. But only 438 were employed in the field for which they were trained at the time the survey was taken. The primary reason (33 per cent) given by the trainees for not finding a job related to their training was the absence of vacancies, as evidenced by unsuccessful applications to different firms. Eighteen per cent had discontinued training. Thirteen per cent had become pregnant or ill, 10.8 per cent had found new jobs not related to training, 7.9 per cent had returned to their former employment, and others (1.9 per cent) had just finished training and were still looking.

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[5] From a social point of view, gains in total income would be a satisfactory measure of benefits. However, benefits to an economic efficiency objective must be measured as gains in productivity. Only if policy makers are indifferent between transfer payments and earned income can changes in total income be used as a measure of benefits from retraining. And, the wording of the Act, "in order to . . . reduce the costs of unemployment compensation and public assistance," makes it clear that policy makers are *not* indifferent.

Second, allowances must be made for cyclical changes in the economy. If improvement in income could be attributed to improvement in the overall economy as, for example, between a prewar and wartime economy, benefits cannot reasonably be attributed solely to retraining. Similarly, if there has been a downturn in the economy this too must be taken into account in evaluating benefits to retraining. To do so we will let ϕ represent the per cent of income attributable to retraining after allowing for changes in the economy. To determine ϕ, the net change in income during the training period of a control group was measured. The group was comprised of a random sample of individuals in the central claims file of the Bureau of Employment Security having six characteristics similar to those of the trainees.[6]

There are two significant factors to be considered in determining the ϕ factor for the benefit equation: (1) the change in income of the control groups, and (2) the nature of the increase, whether earned or transfer payments. Denoting Y_{ct_1} and Y_{ct_0} as the change in total income and $Y_{cp_1} - Y_{cp_0}$ as the change in transfer payments of the control group during the training period, the general economy factor expressed as a per cent may be written as

$$\phi = 100 - 100\left[\frac{(Y_{ct_1} - Y_{cp_1}) - (Y_{ct_0} - Y_{cp_0})}{Y_{ct_0} - Y_{cp_0}}\right]$$

and the benefit equation now reads

$$B = \phi\,[(Y_{t_1} - Y_{p_1}) - (Y_{t_0} - Y_{p_0})]$$

EXHIBIT III

Control Group Experience

Total income after the training period	$ 3,854 (average)
Total income before the training period	3,489 (average)
Transfer payments after the training period	26,000 (total)
Transfer payments before the training period	20,000 (total)
Number in Control Group	104

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[6] A mailed questionnaire was sent to the control group and responses recorded in Exhibit III of the *Massachusetts Retraining Program.*

$$\phi = 100 - 100\left[\frac{(Y_{et_1} - Y_{ep_1}) - Y_{et_0} - Y_{ep_0})}{Y_{et_0} - Y_{ep_0}}\right]$$

$$= 100 - 100\left\{\frac{[104(3,854) - 26,000] - [104(3,489) - 20,000]}{104(3,489) - 20,000}\right\}$$

$$= 100 - 100\left\{\frac{30,000}{344,000}\right\}$$

$$= 100 - 8.7$$

$$\phi = 91.3$$

Third, gross benefits accruing in future time periods must be reduced to present value to be compared with costs occurring at present. To do so a time period must be selected which reflects the remaining working life of the trainee. In the case study the average age of the trainees was 30 years. It is assumed that they would be eligible for retirement at the age of 65, and that therefore the average remaining working life (time period for the present value factor) would be 35 years.

More difficult is the problem of choosing an interest rate to be used in discounting future benefits. The tendency here should be to select a reasonably high rate of interest since, in such cases, one is concerned more with immediate payoff rather than long-term benefits accruing to future generations. Furthermore, as an employee increases in age, the greater the likelihood that: (1) he will be eligible for early retirement, and (2) he will have fewer financial responsibilities. In evaluating the case study future benefits were discounted at a rate of 10 per cent.

EXHIBIT IV

Present Value Factor

Average working life of trainees	65 years
Average age of trainees	30
Time period for present value factor	35
Rate of interest to discount future income to present value	10%
Present value factor (PV)	9.644

Other benefits to efficiency would be the difference between consumption of public goods and services and the amounts paid in taxes for goods and services with and without retraining. For example, an individual may be consuming public medical care without payment while unemployed; whereas with retraining the amount of taxes paid by the trainee should correspond roughly to public services consumed if placement is successful. These benefits, although important, will not be considered here because of the difficulty of measuring them, but they do exist and should be kept in mind.

Net benefits resulting from retraining may then be written as

$$N = PV(\phi B) - C$$

and using the gross benefit and total cost calculations from exhibits I, II, III, and IV

$$N = PV(\phi B) - C$$
$$= 9.644\ (91.3)(443,488) - 633,359$$
$$= 3,900,000 - 633,359$$
$$= 3,266,641$$
$$N = 3,300,000 \text{ (approximately)}$$

and net benefits occurring as a result of retraining in this instance amount to approximately $3,300,000.

This figure is, of course, based upon several major assumptions. First is that the incomes of the retrainees remain relatively constant throughout the remainder of their working lives. One would expect the incomes of those who remain employed to increase and the effect would be simply to increase net benefits. Similarly, it is assumed that without training the incomes of the trainees would have, on the average, remained constant. To the extent that the earned income of the trainees would have increased (or decreased), benefits are again overstated (or understated). But major changes in income, taking the group as a whole, would appear unlikely in the absence of significant changes in the economy. Moreover, the more remote the change the less would be the impact since gains or losses must be reduced to present value.

Second, it is assumed that all of those who found jobs would remain employed throughout the remainder of the period used in discounting gross benefits. This is unlikely since some skills will no doubt again become obsolete, some will not live to the end of the period, and there will be attrition due to health and sundry other factors. To the extent that there is attrition net benefits will be reduced. Factors such as careful screening, aptitude testing for jobs, and careful selection of new skills should act to keep this to a minimum.

A third assumption, and the one most difficult to assay, is related to displacement. To the extent that retraining of workers and placement in the work force redistributes existing work or displaces other workers and does not generate new income for previous labor voids in the economy, benefits accruing to the efficiency objective are overstated. It has been assumed in the analysis that there would be no displacement of workers as a result of retraining.

The displacement problem is a complex one. Its analysis requires distinction between zero displacement, partial displacement, and total displacement. Obviously, zero displacement involves no loss of worktime and income by those already in the labor market. Partial displacement would result in either a loss in worktime, income, or both to those in the labor market. Total displacement would result in a replacement, one for one, of those in the labor market, or about to enter the labor market, by retrained workers.

Generally speaking, in a competitive economy such as that of the United States, it can be assumed that there is little partial displacement or spreading of the work as a result of retrained workers' entering of the labor force, since employers are not likely to hire unnecessary workers if such a practice is avoidable. Total displacement and the question of whether others, particularly younger workers coming into the labor force, have been deprived of potential employment opportunities as a result of this and other retraining, may be another matter. Over 50 per cent of the trainees were enrolled in schools for barbers and beauticians; while 18.5 per cent were being trained as draftsmen, technicians, office machine operators and mechanics; 4.4 per cent as secretaries, stenographers, and typists; and 4.6 per cent as practical nurses. The demand for these occupations in the New England area appears to be far in excess of supply, and one would expect little total displacement of workers as a result of the impact of the retrained workers on the labor force. But the amount of displacement from retraining is a matter of judgment, as is the question of whether this is desirable.

Finally, it has been assumed in the study that administrative costs were negligible. Under the federal program administrative costs would be incurred, and should be attributed to the costs of retraining. This cost might be expected to reduce somewhat the economic benefits of the program. However, a relatively high rate of interest (10%) has been used to discount future benefits. Experience will probably indicate that a lower rate of interest should be used in the analysis of retraining. In light of the opportunity costs of public funds a 5 per cent (or lower) rate of interest would probably be more appropriate. A lower interest rate would increase the value of gross benefits, and should more than compensate for increases in training costs due to the inclusion of administrative expenses.

CONCLUSIONS

It is readily apparent that under the circumstances and assumptions of this case study, retraining is worthwhile. Benefits to the efficiency objective from training the 907 Massachusetts workers amount to approximately \$3,300,000 over the working life of the retrainees. Moreover, the analysis has not taken into account the increased utility to the worker resulting from the opportunity to reexpress his preference as to his field of endeavor. In addition, if redistribution of income is taken as an objective, benefits are again understated. The additional income in the form of subsistence allowances during retraining amounts to an extension of unemployment compensation. To those who are unemployed and to the nation as a whole this may be considered a real gain.

On the national scale similar results may be expected from the MDA program providing its administrators determine what jobs are reasonably certain to be available, and then select individuals for retraining who are unemployed or underemployed, and are willing, and potentially well qualified, to hold these positions. This procedure would simply be one which meets the requirements of the MDA. Properly administered, the federal program should produce national economic and social gains, and help reduce the functional and structural segment of "normal" unemployment.

Planning and Analysis for Higher Education: Promises and Pitfalls

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Planning and Analysis for Higher Education: Promises and Pitfalls*

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Introduction:

Much of the literature on comprehensive long range planning for higher education describes the European experience and planning which has been done by individual countries.[1] In such systems, university spaces are limited: planning and control are usually centralized; admission is restricted to students with high academic potential; and it is possible to closely coordinate educational plans with broader economic and social development objectives as the economic plan stipulates the kind and quantities of professional, technical and skilled manpower requirements needed to achieve national growth targets. Educational planning is conducted in the framework of national goals, priorities and preferred manpower mixes.

In contrast, American colleges and universities are relatively unemcumbered by centralized planning and control agencies. Higher educational opportunities are available to a significantly larger proportion of the college-age population· an "open access" policy prevails in many public institutions; once admitted to college students have a comparatively wide range of choice in selecting courses, switching major fields of concentration, or changing professions once graduated. The United States actually consists of fifty public systems of higher education only some of which are headed by an overall governing agency. Among states with such controlling boards, only a few have functions and duties which extend to budget preparation, comprehensive planning, and allocation of specific educational functions to the institutions under its control. In addition, there are several hundred private colleges which remain a part of the nation's total investment in higher education, but which remain largely independent of the public system.

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* I am indebted to Robert F. Munn and Daniel Rathbun for helpful comments and encouragement on this paper, but remain solely responsible for any errors.

Despite these differences, several recent monographs and papers have suggested the potential contribution of PPB systems analysis to higher education planning.[2] Very often, the philosophical differences which exist between American colleges and universities and those of other countries are not explicitly treated. These differences are real, affecting the operational and organizational character of American institutions of higher learning. To ignore them is to invite the rebuttal by reluctant academic administrators that models of systematic planning cannot be superimposed on American colleges and universitites. It may be argued that efforts to do so will promote institutional sameness and/or mediocrity; that planning threatens the individual character of specific institutions. When college administrators do accept the necessity for systematic planning, it will often be insisted that what planning that is done take place in utmost secrecy.[3]

Despite differences in goals and educational philosophies, the production function concept of higher education can be generalized to a very small college or a more complex multiversity, to a centrally planned educational system or to a loosely-knit one. Resources in the form of faculty, space, classrooms, and laboratory equipment are arrayed in a manner to expose students to various educational experiences established by departmental and institutional curricula. The mix between different academic programs at the same educational level, between graduate and undergraduate programs and between formal instruction, research and service programs of the institution; are expressions of prescribed institutional missions, preferences established by the institution itself, or student preferences in colleges which permit students a wide degree of freedom in course selection. Alternative combinations of goals require different sets of resource mixes if objectives are to be achieved in a timely and orderly manner.

This paper discusses research which has attempted to link the activities of a single institution of higher learning to the public system of which it is a part. The successive levels of planning and decision-making in higher education are: decisions made at the departmental or college level the overall activities of a single institution; and strategies and alternatives confronting a state system of higher education. This paper is an effort to bridge these three policy thresholds.

The first part of the paper discusses the flow of students among decentral departments within a single institution of higher learning. Some of the important determinants on educational costs and institutional outputs are treated in this section. The second part compares costs and outputs of the public colleges and universities which make up the West Virginia system of higher education. Public policies affecting private colleges in West Virginia are also considered in the second section. Although there are gaps in our complete understanding of American higher education as a total system, PPB analysis assists in defining the critical variables in educational planning and facilitates comprehensive long-range planning and improved management decision-making.

Institutional Cost Models

The need for careful attention to unit costs in higher education has been recognized for many years. Whether an institution is an independent private college or a public university, the expenditure of funds is a matter of concern to students, faculty, alumni, trustees and the public in general. "Wise spending . . . is an important and difficult public duty, how well it is discharged by the administrators of institutions depends largely on the amount and quality of information available to them."[4]

Various dimensions are used for unit cost analyses in higher education. Common measures include cost per student, cost per student class hour, or cost per student credit hour (credit hour value of a course times and number of students enrolled). The latter measure is the most meaningful for operational purposes since the number of credit hours carried by a student usually determines tuition charges assessed against him, distinguishes between part and full-time attendance and it is through the accumulation of credit hours that eligibility for graduation is determined. Knowing something about study habits of students, it is possible to estimate the number of full-time students in residence from credit hour data, or to translate enrollment projections into estimated institutional credit hour "production" in future time periods.

Unit cost data are more meaningful when they can be reviewed over a period of years and trends in cost behavior can be detected. Table I displays selected data of eleven private institutions of higher learning reported in a recent study of private colleges and universities in New York State. Most institutions maintained a fairly stable student-faculty ratio between the two periods, but Table I reflects that faculty productivity, as expressed by average credit hours per faculty member, declined in seven of the eleven institutions.

Table I supports the view that unit instructional costs are the resultant of the interplay of many factors, not least of which are faculty salaries, numbers of students in attendance, and indirect instructional costs. Average salaries paid all faculty ranks increased in each institution at an approximate annual rate of seven percent between 1963-64 and 1966-67. In some institutions, increases in faculty student credit hour productivity more than offset the upward pressure on unit costs caused by higher salaries. Institution E shows a decrease of five dollars in credit hour costs over the four-year period and over one-third increase in average credit hours per faculty. However, Institutions G and H show productivity increases coupled with increases in average credit hour costs.

Table I Selected Statistical and Financial Data for Private Colleges and Universities in New York State

	Student-Faculty Ratio		Credit Hours Taught Per Faculty		Cost of Instruction Per Credit Hour	
Institution	1963-64	1966-67	1963-64	1966-67	1963-64	1966-67
A*	12.6:1	12.1:1	328	326	$95	$114
B*	11.3:1	11.4:1	237	279	52	66
C	9.0:1	8.2:1	311	275	59	81
D*	11.8:1	11.7:1	305	258	37	57
E	10.0:1	11.9:1	302	427	59	54
F*	14.8:1	12.3:1	393	341	48	61
G	10.2:1	12.4:1	314	357	67	72
H*	14.5:1	15.7:1	379	459	36	52
I	14.0:1	14.0:1	445	412	N.A.	44
J	N.A.	17.0:1	N.A.	564	32	42
K	19.0:1	19.0:1	596	558	20	29

* Graduate and Professional Degree Programs Included with Undergraduate Credit Hours

Source: Select Committee on the Future of Private and Independent Higher Education in New York State, New York State and Private Higher Education, (Bureau of Publications, State Education Department, New York) January, 1968.

Aggregate data such as Table I mask important determinants of instructional cost, e.g., the mix between different faculty ranks at different salary schedules, the proportion of variable, semi-variable and fixed institutional costs and changes in the proportions of each over a period of years; the higher costs intrinsic to same academic disciplines (solid-state physics compared to history, for example) and the proportion of total enrollment in more costly academic programs. Average instructional costs in senior-level courses are higher than freshman classes graduate courses are more expensive than undergraduate instruction. Therefore, changes in the mix of students at different degree levels is an additional determinant of instructional costs.

Data such as Table I are commonly used by academic administrators and trustees for purposes in indicating institutional cost trends. So long as the surface quality and limitations of such data are recognized aggregate instructional cost data are useful indicators of overall institutional cost performance. But the tip-of-the-iceberg quality of such data are fully appreciated by educational decision-makers.

Table II is an alternative, more detailed method of presenting instructional cost. This table displays the study patterns and cost of selected undergraduate programs at a major state university. The table has advantages over conventional cost models since it captures an additional dimension of instutional costs and instructional outputs.

Undergraduate instructional programs require that students seeking specific degrees take a certain number of courses outside the department in which they are majoring. Such courses may be functionally related to the student's field of concentration, e.g., mathematics courses for engineering majors. Other courses taken outside the major field serve the purpose of broadening the student's point of view and act as a safeguard against overspecialization. Still other departmental curricula permit students some degree of latitude in selecting "unrestricted" electives -- courses or subjects which appeal to them individually and which are not necessarily offered by his major field of concentration.

Whatever the reasons for interdepartmental student course demands, the practical result is a joint cost associated with undergraduate degree programs in American colleges and universities. Authorization for new faculty and budgeting decisions are made to individual departments or professional schools, but in preparing budgets, department chairmen cannot accurately estimate future needs without some knowledge of the number of students outside the department who will register for the department's course offerings. The chairman of the mathematics department, for example, must have some notion of the number of business administration, engineering and other students majoring outside his department who will seek entrance to mathematics courses before he can properly plan his departmental requirements. Table II fixes the "external" demands placed on individual departments by the undergraduate curricula of the several departments. Conceptually, Table

TABLE 2: EXAMPLE OF THE DISTRIBUTION OF UNDERGRADUATE CREDIT HOURS AMONG VARIOUS DEPARTMENTS, AND AVERAGE EDUCATIONAL COSTS BY DEPARTMENTS AND BY DEGREE MAJOR

		ACADEMIC DEPARTMENTS RESOURCE INPUTS ($) ($000 OMITTED)											
Degree Major	Number of Students	$150 AGR.	$141 BIOL.	$91 CHEM.	$220 ENGL.	$134 MATH	$76 POL SCI	$130 BUS.	$282 ENGR.	$204 EDUC.	Credit Hour Total By Major	Cost Per Sem. By Major	Cost/Credit Hour By Major
AGR.	633	7.21	.70	1.74	1.97	1.83	.19	1.39	.87	.17	16.1	$410.53	$25.50
BIOL.	214	.53	5.27	3.35	1.83	1.35	.49	.26	0	2.62	15.7	430.55	27.42
CHEM.	80	.04	.58	7.46	3.20	3.35	.30	.34	.04	1.07	16.4	341.30	20.81
ENGL.	146	.97	1.91	.46	7.81	1.44	.22	.12	0	2.66	15.6	401.05	25.71
MATH	157	0	1.91	1.27	2.39	6.49	1.08	.40	.19	1.99	15.7	356.20	22.69
POL SCI	214	.06	.51	.90	2.73	1.16	7.65	1.55	0	.15	14.8	297.30	20.09
BUS.	763	.10	.31	.41	2.17	1.18	1.29	9.80	.02	.08	15.4	250.88	16.29
ENGR.	896	.03	.03	1.77	1.33	3.58	.45	.75	6.67	.07	14.7	430.28	29.27
EDUC.	733	.28	1.64	.74	3.47	.65	.55	.52	0	7.04	14.9	404.78	27.17
Total Credit Hours	3836	5139	3775	5324	9392	7784	3882	9925	6581	6776			
Cost Per Credit Hour (Dept.)	$	29.29	38.44	17.17	23.51	17.27	19.67	13.16	40.97	30.11			

INSTRUCTIONAL OUTPUTS

II is similar to an input-output system. The production of "products" (students) by some "sectors" (academic departments) of the "economy" (entire college or university) engenders resource requirements (space, equipment, faculty, etc.) in both the expanding sector of the economy plus its suppliers.

The essential characterstics of this system are shown in Table II. The table represents a cross-section of credit hour course registrations of selected undergraduate degree candidates (all class ranks, freshmen through senior) at a university during one semester. Figures in the body of the matrix relate to the number of credit hours demanded by different degree majors. Students in agriculture registered for 7.21 hours of agriculture courses; .70 hours of biology, 1.74 hours of chemistry etc. These values are equivalent to technical input coefficients of a conventional production process. Understandably, the credit hour coefficients assume maximum values when a specific student major row intersects the departmental column in which he majors.

Dollar inputs shown at the head of each column refer to direct faculty salaries only and without reference to composition by ranks. Only that portion of faculty salaries which is attributable to formal undergraduate instruction are included, i.e., graduate instruction, departmental research and service activities are excluded.[5] Average faculty costs per departmental credit are shown at the base of the table, the resultant of dividing the total dollars spent by the department by total hours taught. More important from the point of educational planning is the cost per semester for degree majors shown in the next to last column of Table II. These costs are the summation of the average number of credit hours demanded by each degree major times average departmental credit hour cost, $\Sigma_{i=1}^{n} d_i c_i$.

This method of displaying instructional costs is similar to the mission concept of PPB. The output of biologists depends upon resource allocations to both the biology department as well as to all other academic departments in which biologists study. Attention is redirected from departmental budgeting to the considerations of joint costs of supplying graduates with specific intellectual skills. Planning and budgeting cut across traditional departmental organization, thereby facilitating balanced resource allocation and inter-departmental coordination.

For example, assume that the Department of Political Science were to increase by fifty the number of undergraduate majors in the department over the next several years. If it is further assumed that faculty requirements are directly proportional to the number of students in residence (which would be in the case if the preferred student-faculty ratio for undergraduate instruction had been achieved) and that average costs equal marginal costs, then fifty additional political scientists would require approximately $14,665 incremental faculty salaries, at current compensation levels. About $7,500 of this increase would be required in the Political Science Department, but significant amounts would also be needed in English and Mathematics. A similar expansion of fifty biology majors would create need for $21,500 in new faculty salaries. In this case, the expanding department would again acquire the biggest portion of the increase, but English, Mathematics and Political Science would also require additional faculty positions based on the affinity of biology students to take courses listed in these three departments.

This is not trade-off analysis in the formal sense such comparisons need not imply that political scientists are preferable to biologists simply because the former are less costly to "produce." On the contrary, a negative connotation is usually associated with academic goals which are pursued on the cheap. Instead, the primary reason for tracing out cost implications of educational programs is to assure balanced resource planning among those academic departments which will be affected by the expansion. This point can be especially important to those departments which have few students majoring in them, but which render instructional support to a large number of students seeking degrees in other fields.

Factors Influencing Student Demand Patterns

Study patterns of specific degree candidates have an important effect on resource planning for individual departments of a college or university therefore, it is appropriate to interject here some comments on the stability of student demands over a period of years and the utility of course registration matrices such as Table II as a forecasting device. A five year review of such data in a public university suggests that three variables have the greatest effect of the intra- and extra-departmental course demands generated by specific degree candidates.

First, the level of instruction has the most significant influence. The interdisciplinary portion of most undergraduate curricula occurs in the early stages of degree programs. Freshmen and sophomores ordinarily register for a variety of courses in different departments; juniors and seniors on the other hand tend to concentrate in the courses offered in their major field. Graduate programs are also almost entirely intra-departmental programs.

Second, departmental curricula changes have an obvious influence and a cummulative effect over a period of years. For example, students majoring in one department, (which we will call "X") once had the option of taking courses in a cognate discipline (Department Y). Some years ago, the faculty of Department X formally instituted the requirement that X majors take three courses in Department Y. As successive entering students became subject to the new departmental requirement, the average number of credit hours carried by X students in Y department gradually increased and eventually stabilized.

The third factor influencing the stability of student registration patterns over a period of years is the number of students enrolled for differentiated degrees. This is a problem related to the appropriate level of aggregation of data in order to achieve predictive accuracy. When too few students are enrolled in a specific degree program, the courses demanded by them are likely to reflect individual preferences. Thirty or more students (in a highly specialized university) appears sufficient for prediction within reasonable limits. An exception is graduate programs which, as noted, are almost entirely "in-house" educational programs.

Enrollment matrices such as Table II are a flexible planning tool which can assist in a variety of institutional planning problems. Class scheduling, the aggregation of related academic departments into cluster campuses, and decisions concerning building priorities; and other questions are materially assisted by enrollment configurations such as Table II. Matrices can be updated periodically to reflect current trends in student demands. In colleges where registration data are captured and stored electronically, such tables can be printed out within a few days following the beginning of an academic term.[6]

Institutional Goals and Cost-Simulation Models

Thus far, no consideration has been given to institutional goals, the priorities assigned to each, or the effects different combinations of goals have on institutional cost performance. To a large extent, the problem of choosing an appropriate mix among alternative combinations of educational objectives is confined to large universities. Among four-year colleges whose primary if not sole purpose has been formal instruction for first-degree students, the question of priorities among different institutional objectives seldom arises; however, it is a significant one confronting most universities.

The goals structure of a university is ultimately reflected in the professional services expected of the academic faculty. The "full professional life" in universities consists of varying proportions of classroom instruction (at different educational levels), departmental research, service to the community and/or the academic discipline, and willingness to serve on a variety of committees, theses direction, student advisement and other forms of uncompensated institutional service. Each of these activities constitute an important segment of a university's overall mission, however, no two institutions will necessarily place the same amount of emphasis on each. Nevertheless, the importance of institutional objectives in educational resource planning and the balance struck among alternative university objectives is becoming increasingly apparent; the missions pursued by a university can be the dominant variable in educational cost equations.[7] Flexible planning models should have the capability of appraising educational planners of anticipated effects different combinations of goals will have on institutional performance.

Such considerations are explicitly treated in a university cost and output simulation model currently being developed at VPI.[8] This model will permit alternative assumptions about institutional objectives, expectations about faculty service (policy parameters) and the joint cost nature of certain educational programs.

In abbreviated form, the general characteristics of this model are:

Given:

(a) A university of stated size (about 10,000 students) with a variety of differentiated graduate and undergraduate degree program offerings,

(b) alternative assumptions about the priority of faculty assignments among competing institutional objectives (upper and lower division undergraduate instruction; graduate instruction; research, professional service, institutional service) and the proportion of total faculty salaries which can be assigned to each of these missions,

(c) historic drop-out rates of specific degree candidates and/or the percentage of students who switch fields between initial entry and graduation,

(d) a lower boundary on the minimum number of declared degree candidates in degree programs before an academic department is recognized as a departmental entity,

(e) an upper boundary on the maximum enrollment permitted in specific degree programs or departments,

(f) joint instructional costs experienced in some degree programs.

Find:

The optimum allocation of limited spaces to various degree programs which maximized the expected discounted lifetime earnings of all graduates of the university.

This model attempts to bridge the differences between the often-quoted values of institutions of higher learning and the economist's view of higher education as a human capital-creating process. Variables (b), (d) and (e) are institutional policy parameters which can be manipulated by institutional administrators. The lower bound on the number of students seeking specialized degrees recognized the fact that university's resources are limited and that no institution can accomodate all educational demands. The upper bound on departmental enrollment assures that the value of diversity in higher educational experiences is preserved that a university does not become overly-identified as strong in some academic fields, but as mediocre to weak in others. Most university administrators on the other hand probably would not accept the improvement of lifetime earning potential of graduates as the sole purpose for higher education, although the economic logic and consistency of this criterion is difficult to fault from the standpoint of social cost-benefit analysis. As a simulation model, the main objective of this research effort is to strike a balance between views held about the purposes of the university and to compare alternative costs, outputs and benefits of various institutional policies.

Certain parts of this model are currently available. Table III displays the direct cost of instruction of selected degree majors at different instructional levels under two sets of assumptions about the deployment of faculty energies to different ends. Costs shown in Table III are joint (interdepartmental) costs based on past registration patterns of degree candidates. Case I assumptions provide faculty members with opportunities for departmental research and public service activities, knowledge-creation activities which are a vital component of a university's overall mission. Case II assumptions might be more appropriate for a university which is primarily concerned with the transmission of knowledge and less so with its creation, (for example, an emerging public university in an urban community which offers graduate work in a limited number of academic fields). Under either set of assumptions, the portion of faculty salaries assigned to formal instruction is changed as are the costs for the several types of degree majors.

Dropout rates and/or the amount of switching among major fields affect the cost of instruction to specific educational levels. The cost per semester per lower division mathematics major is shown to be $143.75 in Table III (Case I): however, only eighty-nine percent of entering mathematics majors "survive" to the first term of the

TABLE 3: Joint Instructional Costs Of Selected Degree Majors Under Alternative Assumptions Of Institutional Missions

CASE I[1]

Academic Departments or Degree Program	Average Cost per Credit Hour per Degree Major (Academic Program Costs)			Semester Costs by Degree Major		
	Lower Div.	Upper Div.	Graduate	Lower Div.	Upper Div.	Graduate
Psychology	$11.35	$37.13	$142.24	$170.69	$579.42	$1,576.25
Biology	29.25	33.47	80.44	462.06	513.82	725.76
Mathematics	9.34	30.69	64.72	143.75	459.08	431.39
Business & Economics	11.08	19.50	77.69	168.58	305.08	674.35
Engineering	10.61	33.08	108.07	165.95	518.73	918.61

CASE II[2]

Academic Departments or Degree Program	Average Cost per Credit Hour per Degree Major (Academic Program Costs)			Semester Costs by Degree Major		
	Lower Div.	Upper Div.	Graduate	Lower Div.	Upper Div.	Grad.
Psychology	$19.45	$35.54	$162.57	$292.57	$507.86	$1,801.52
Biology	35.21	27.77	124.40	556.18	427.13	1,122.36
Mathematics	15.92	22.67	93.05	245.17	339.05	620.19
Business & Economics	19.23	14.19	132.60	292.54	222.33	1,150.92
Engineering	19.14	23.06	151.81	299.34	361.55	1,288.04

[1] **CASE I Assumptions:**

(a) Full Professors teach six hours per semester; 2/3 in graduate-level courses; 1/3 in upper division undergraduate courses. Associate Professors teach nine hours per semester; 2/3 in graduate-level courses; 1/3 in upper division undergraduate courses. Assistant Professors teach twelve hours per semester; 1/4 in graduate-level courses; 3/4 in upper division undergraduate courses. Instructors teach twelve credit hours per semester; 2/3 in upper division undergraduate courses; 1/3 in lower division undergraduate courses.
(b) Graduate Teaching Assistants teach six hours per semester; lower division courses only.
(c) Eighty percent of faculty activities are allocable to the primary functions of formal instruction, research and public service. The remaining twenty percent is utilized in student advising, committee work, and other forms of uncompensated institutional service.

[2] CASE II Assumptions:

(a) All full-time faculty ranks teach twelve credit hours per semester and are distributed to various instructional levels as follows:

Rank	Instructional level
Full Professor	3/4 Graduate; 1/4 upper division
Associate Professor	2/3 Graduate; 1/3 upper division
Assistant Professor	1/4 Graduate; 1/4 upper division; 1/2 lower division
Instructor	1/4 upper division; 3/4 lower division

(b) Graduate Teaching Assistants teach six hours per semester; lower division courses only.
(c) Eighty percent of the faculty activities is allocable to the primary functions of formal instruction, research and public service. The remaining twenty percent is utilized in student advising, committee work, and other forms of uncompensated institutional service.

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junior year. Therefore, the cost per successful math student to the junior year is $614.12, allowing for those who dropout or switch fields. Once mathematics majors attain the third year, however, they are virtually certain to graduate two years later this is not true of other upper division undergraduate programs.

As an example of the type of output expected from the cost simulation model, the four-year direct faculty salary cost per first-degree graduate in the fields listed in Table III are: psychology -- $2,926; biology -- $3,633; mathematics -- $2,418; business and economics -- $1,942, and engineering -- $4,103 (Case I assumptions).

Additional refinements in this model include: the inclusion of departmental indirect and general institutional costs to derive a total cost of education; sensitivity that average class size in some disciplines has on student performance as measured by class failure rates;[9] linkage of the total cost of supplying specific manpower skills to expected lifetime earnings of graduates. Maximization of aggregate lifetime earnings of all graduates, subject to policy constraints imposed by the institution, provides a superior basis for the allocation of limited institutional spaces to the alternative educational programs.

Analysis for Public Higher Education Policy

Planning for a single institution of higher learning cannot be conducted entirely independent of the larger community of which it is a part. This is especially true of state-related colleges and universities. Long-range plans and goals for public higher education must be developed within the context of existing state priorities and fiscal constraints. Entirely different problems are encountered at the state level of educational planning: pertinent data to guide decision-makers are often unavailable; gaps remain in the ability to consider higher education in a total system framework.

Despite these problems, questions which must be dealt with include:

> For what special segment of the population is education to be provided? What is the preferred mix between four-year academic, graduate, junior college and adult educational programs?
>
> What limit, if any, is to be placed on non-resident enrollment in public colleges?
>
> How shall cost burdens be distributed among the clients of higher education? What will be state, local, federal and student cost shares?
>
> What alternative educational outcomes can be expected from an "open-access" as opposed to successively more selective admission policies?
>
> Regional availability of educational opportunities is desirable, but what practical limits shall be placed on this objective to guard against over-expansion and/or redundant capacity in the educational system?
>
> Does the public system threaten to displace the private colleges in the state? How can the dual system of higher education be preserved in view of the religious affiliation of many private colleges and the constitutional prohibition against public aid to religious institutions?

Answers to these questions are rarely easy to find, even after protracted discussion and analysis, the "optimum" educational policy for a state cannot be sharply defined. Thus, the analyst has the comforting knowledge at the outset that the implications of his research will be regarded as objectionable by at least some segment of the academic community and/or educational clienteles.

West Virginia is a case in point. West Virginia has more institutions of higher learning per capita than any other state in the nation. The public system is composed of eight four-year colleges and two universities, the latter being the only institutions which offer graduate work. In addition, several public colleges either jointly or independently operate six two-year branch colleges in various sections of the state. West Virginia University also maintains a center for graduate and professional degree students (Master's level only) in Charleston, the state capitol.

Parallel to the public system are ten private colleges; seven four-year colleges offering academic work in liberal arts and pre-professional degree areas; three are junior colleges.

Despite the endowment of public and private investment in higher education facilities, the incidence of college attendance among eligible West Virginia youngsters is lower than the national average. In 1965, 35.8 percent of the states' high school graduates continued on in higher education, compared to about fifty per cent nationally.[10] Although the rate of attendance has been increasing in the last several years, the population decline for the state is an additional factor in long-range planning for higher education.

Historically, West Virginia has provided liberal support for higher education, both in absolute terms and in accordance with her ability to pay. From 1965 to 1969, appropriations for higher education have increased over ninety percent, or $49 million (operating expenses only) in FY 1968-69. In 1967, the state ranked 47th in per capita income and 34th in per capita tax revenues, but 26th in per capita expenditures for higher education. Current projections estimate expenditures of $83.1 million in 1975.[11] This is a significant outlay in terms of West Virginia's ability to pay and in view of its inadequate tax base. Fiscal constraints therefore mandate the need for prudent management and development of the public higher education system.

The West Virginia Legislature has long recognized this need. For a number of years, the legislature has published a compendium of pertinent statistical data to review the operations of each public college and university and to lend substance to budget hearings. (Prior to 1969, the legislature was, de facto, the ultimate coordinating body for public higher education in West Virginia since each institution's budget was individually approved by the legislature. In 1969, a bill creating the Board of Regents was enacted. Among other duties, the Regents will prepare and submit consolidated budgets for all public institutions and assign educational missions to the several colleges and universities.) Included in data compiled by the legislature are student enrollments, student-teacher ratios, and average salaries at each public college.

One computation of particular interest is the State's operating budget appropriation per enrolled student in each college, and the trend in public costs per student over the last several years. Table

IV summarizes these costs for each college and university in West Virginia. Such comparisons do not consider the differences in educational quality among institutions, nor do they account for the higher costs of graduate and professional degree programs available at some institutions. Also overlooked are differences in research and service productivity among public institutions, albeit very difficult to measure such outputs. Per student appropriation data can also invite invidious comparisons by regional supporters of individual colleges and universities. The desire to equalize per capita expenditures by spending agencies pursuing similar purposes has an obvious and persuasive appeal to elected representatives data such as Table IV support those who argue the need to "close the gap" between the have and have-not institutions.

A superior basis for comparing institutional performance is the four-year public cost per graduate. Annual appropriations per student overlook the four-year duration of undergraduate programs per graduate cost comparisons must take into account the effect drop-out rates have on instructional costs. If only fifty percent of those students who initially enroll actually graduate then two students must start for each graduate four years later.

Attrition rates of West Virginia youngsters in each college in the state are available.[12] Thus it can be shown that over the last nine years, an average of 40.7 percent of entering students at Bluefield State College graduated four years later 52.3 percent of first year students at Concord College and so on. When dropout rates are coupled with each institution's

TABLE IV

Appropriation per Full-Time (Equated) Student in West Virginia Public Colleges and Universities

School	1964-65	1965-66	1966-67	1967-68
Bluefield	$ 772	$ 711	$ 705	$ 760
Concord	718	691	845	1,096
Fairmont	626	584	640	854
Glenville	732	662	678	869
Shepherd	690	697	746	901
West Liberty	530	580	633	780
West Virginia Tech	656	635	763	956
West Virginia State	696	745	763	1,052
Marshall University	731	619	660	774
West Virginia U.	1,052	1,078	1,156	1,258

Source: Subcommittee on Higher Education, *A Study of State Institutions of Higher Education in West Virginia* (State of West Virginia, Charleston, 1968), p. 23.

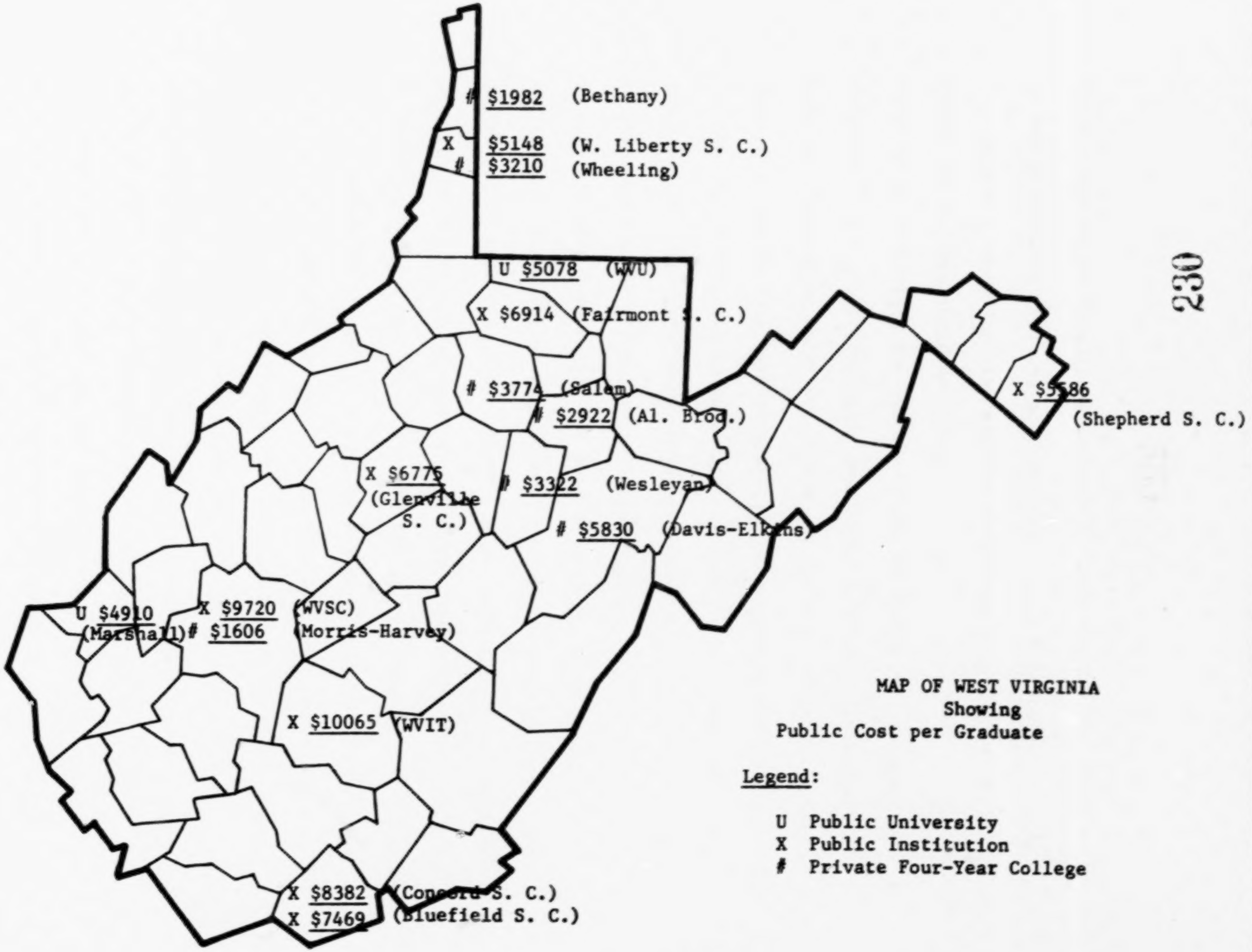
budget appropriation, the comparative cost performance among colleges is significantly altered. For example, the public subsidy per graduate at West Virginia University is \$5,078 and \$4,910 at Marshall University, based on the 1967-68 budget appropriation and allowing for the higher costs per graduate student enrolled at each university. The equivalent cost at the four-year colleges averages \$7,541 per graduate, ranging to over \$10,000 at one four-year college.[13] The four-year public subsidy per graduate has obvious advantages over annual student subsidies as an estimate of each institution's "cost effectiveness."

Curiously, there is an inverse relationship between the public cost of education and institutional quality as best the latter can be estimated. Either close to or over half the faculty at the two universities have generally accepted terminal teaching credentials (Ph.D. or equivalent) and library holdings numbering hundreds of thousand volumes. The state colleges have an average of fewer than one-fifth faculties with a doctoral degree and are together over half a million volumes short according to minimum American Library Association standards.[14] However, the effects of scale could also be a factor in the superior cost performance at the two universities. Marshall has 7,000 students enrolled; WVU over 13,000. The largest four-year college has just over 3,000 students while the remaining state colleges average about 1,500 full-time students. It would also seem logical that admission standards and the academic potential of beginning students influence the class survival rates for each institution, but information of this sort is not generally available. The stated requirements for entrance to each public college are similar, but the actual academic potential of entering classes at each institution is not known.[15]

An alternative means for the State to provide higher educational opportunities for its youngsters is the West Virginia Scholarship Plan. Under this program, a West Virginia high school graduate with the intellectual ability to continue on to college, but not the financial resources, can receive a public scholarship. The scholarship carries a maximum stipend of $600 per year and can be exercised in any college in the State, public or private. This program is similar to those adopted by New York, Michigan and other states and has been found to be not in violation of the constitutional prohibition against public aid to religious institutions. Other objectives of such plans include the equalization of tuition differentials between public and private colleges (about $750 per year in West Virginia in 1965) and to help redress the balance in enrollemnt between public and private institutions. (In 1950, total national enrollment was evenly divided between public and private colleges. In 1964, the private colleges' share declined to 35.7 percent while in West Virginia for the same year, only 23.2 percent of total enrollment was accounted for by private colleges.) The Scholarship Plan has gained wide support in West Virginia as it recognized the contributions and financial constraints facing the private colleges.

Figure I summarizes the effects the Scholarship Plan would have on public cost and regional availability of higher education in the state. The public subsidy calculated for each public institution

FIGURE 1: Public Subsidies Per Graduate in West Virginia Public and Private Institutions of Higher Learning



# $1982 (Bethany)
X $5148 (W. Liberty S. C.)
# $3210 (Wheeling)
U $5078 (WVU)
X $6914 (Fairmont S. C.)
# $3774 (Salem)
# $2922 (Al. Broad.)
X $6775 (Glenville S. C.)
# $3322 (Wesleyan)
# $5830 (Davis-Elkins)
X $5586 (Shepherd S. C.)
U $4910 (Marshall)
X $9720 (WVSC)
# $1606 (Morris-Harvey)
X $10065 (WVIT)
X $8382 (Concord S. C.)
X $7469 (Bluefield S. C.)
MAP OF WEST VIRGINIA
Showing
Public Cost per Graduate
Legend:
U Public University
X Public Institution
# Private Four-Year College

takes account of the number of students who can be expected to graduate in four years, based on the past performance of West Virginia students in the public colleges. The equivalent four years subsidy per graduate for those students who elect to attend one of the private colleges is based on an assumed average annual award of $500 per scholarship recipient. (These costs are strictly comparable. The historical survival rates used for the private colleges are based on the performance of West Virginia students only; non-resident student survival rates in no way distort the calculations.) Figure I clearly demonstrates that the Scholarship Plan is an alternative means of delivering higher educational opportunities which also serves the additional goal of economy in the higher education system. Moreover, this economy can be achieved at no apparent sacrifice of educational quality. The private colleges are at least on par with the public four-year colleges on the basis on library holdings, and are generally superior in terms of faculty credentials.

Given the fiscal constraints faced by the State and the performance of the present educational system, it is possible to consider some alternative strategies for future development of higher education in West Virginia. A policy of simultaneous upgrading of all public colleges is one possibility, but surely the most costly one. It would require an estimated $6.75 million to bring the eight State Colleges up to minimum A.L.A. standards for library holdings for colleges of equivalent size (cost to shelve only; net of capital costs). This sum is greater than the cumulative total of all State appropriations for equipment acquisitions of all colleges and universities over the last three years. The upgrading of other factors of production in the educational process would have far greater cost implications.

Selective upgrading of some institutions will surely be objectionable to those not so favored. But if it is true that there are economies of scale in higher education and/or undergraduate education in universities is generally more cost-effective, should one or more of the existing state colleges be converted to a regional university? If so, what additional factors should be considered in the selection process? Would it be feasible to establish an entirely new university at a new location rather than select one among the eight state college candidates for university status? These questions have far-reaching implications, but the answers to them are not at all obvious.

An examination of the distribution of cost burdens of higher education suggest a third alternative which could be the most objectionable to those directly affected by higher education. The public institutions are virtually totally reliant on the legislative appropriation for operating expenses. Only a small fraction of student fees goes into the operating fund accounts of the institution where collected. The State sets an upper limit on the amount of tuition, registration and other special student fees that can be charged by the public institutions. The current total cost per semester is approximately $160 for a West Virginia resident. The largest portion is deposited in a Special Revenue account used only for the cost of current and future capital improvement projects. Consequently, very little of the income from student charges is used to pay for the current cost of education; most of the income from fees goes to capital costs.

If the legislature were to approve a new student fee of, say $100 per semester, dedicated to offsetting operating expenses at the institution at which collected, an estimated $7.2 million in additional operating revenue would become available to the colleges and universities to supplement the current public subsidy. Since fairly accurate estimates of future enrollments are made for each college, intermediate ranged financial planning by the colleges would also be improved. Operating income would be partially linked to student enrollment; dependence and uncertainty over the legislative appropriation would be eased. However, this alternative would also directly affect the 36,000 students enrolled in the state institutions by making the private cost of public education that much more expensive to them. No doubt a tuition increase would cause an additional financial burden to some students and their families. Therefore, a component part of this strategy could be a simultaneous increase in the funds appropriated for the Scholarship Program ($500,000 in FY 1969-70) which is equally available to students attending the public colleges.

Conclusions

Based on the historical performance of students in the educational system, future outcomes of educational strategies available to West Virginia can be estimated. Existing ten-year enrollment projections for each institution can be converted to aggregate credit hours taught; to credit hours demanded by specific class ranks; to expected number of graduates of each institution and, given out-migration patterns of college graduates, the number of first-degree recipients who may be expected to find initial employment in West Virginia can be approximated. Such projections assist the deliberations of decision-makers by narrowing attention on substantive issues central to long-range educational planning. It is an error, however, to confuse such studies as attempts to specify optimum educational strategies. Estimates of resource inputs and institutional outputs for future time periods are vital for comprehensive institutional planning, but sufficient data are seldom available to prove Alternative A is superior to B; that an incremental appropriation of $X million will yield an increase of $Y million in future lifetime earnings of graduates. The proper objective of PPB systems analysis is to probe for answers to the latter questions. Some imaginative studies and promising strides toward these ends have been reported to date, but the current state of the art of systems anlysis in higher education is still in an early stage of development. Choice among alternative educational policies remains largely a matter of judgment.

Another pitfall associated with the application of PPB is the possible reaction of educational policy-makers to such efforts. Two entirely opposite responses may be envisioned. On the one hand, educational administrators, who are very busy people with many concerns, may interpret PPB as some type of panacea for many problems facing American higher education. Such over-optimism is clearly unwarranted. Systems analysis can assist in the solution of some problems, on others, such as the causes and cures of student unrest, the concept has practically nothing to offer.

The opposing reaction may be the argument that universities are so complex, that authority is so splintered among different parts of the institution, and that universities are so unresponsive to change, that no system of rational planning and decision-making is truly applicable to institutions of higher learning. This seems to be the view of Jacques Barzun in his recent book, The American University. "The essence of university administration defies analysis; it is a branch of the black art."[16] Operations research, systems analysis, PPB and related concepts are conceded to be scientific instruments, although those unfamiliar with them might classify them in one of the occult branches of science. Does it necessarily follow that the objectives of management science and the operational realities of higher education cannot be reconciled? We would prefer to think that there is ample opportunity to introduce a little scientific method in the area of comprehensive long-range resource planning for higher education.

FOOTNOTES

[1] The Organization for Economic Co-Operation and Development has conducted a number of studies along this vein. See Mathematical Models for Educational Planning, (OECD, Paris, 1967); The Mediterranean Regional Project: Planning Education for Economic and Social Development, (OECD, Paris, 1963); and Efficiency in Resource Utilization in Education, (OECD, Paris, 1969).

[2] Among other examples, see Harry Williams, Planning for Effective Allocation in Universities, (American Council on Education, Washington, D. C., 1966); Coordinating Board, Texas College and University System, Guidelines for Planning in Colleges and Universities, (Especially Volume I, "Planning System"), Texas A & M University, Bryan, Texas, 1968).

[3] Paul Dressel, "Comments on the Use of Mathematical Models in Educational Planning" in Mathematical Models in Educational Planning, p. 275.

[4] California and Western Conference, Cost and Statistical Study (University of California Printing Department, n.p., n.d.).

[5] Exclusion of costs other than faculty salaries does not seriously underestimate the "true" direct cost of instructional programs. A recent study of cost behavior in several universities, similar in size and academic offerings to the institution in Table II, concluded that salary costs comprised at least eighty percent of total expenditures among all academic departments studied, and in some departments represented one hundred percent of total expenditures. See Peter A. Firin, et. al., University Cost Structure and Behavior, (Graduate School of Business Administration and Department of Economics, Tulane University, New Orleans, 1967), p. 106.

[6] A computer program has been written which prints five year projections of enrollments in high-density core courses. These projections can be made available within fifteen days of the opening of a given semester and, given estimates of future enrollments, course registrations for the equivalent term over the next five years are projected. The program utilized the exponential smoothing technique. See, Marvin Gould, "Core Curriculum Demand Estimation for West Virginia University," (unpublished MBA thesis, College of Commerce, West Virginia University, Morgantown, 1967).

[7] The significance of an institution's goals to its cost performance has been well-stated in a recent study. "Different goals with respect to different universities or different programs within universities may be reflected in significant cost variances between institutions. Significantly higher unit costs in one institution than in another may merely reflect a policy decision to play more for a particular factor of production than for another, possibly in the hope of acquiring greater 'quality' in that factor." Firmin, et. al., op. cit., p. 26.

[8] Duncan Bailey, Paul Hamelman, Charles Schotta, "Optimum Allocation of University Spaces," Occasional Paper #247-A, (College of Business, Blacksburg, 1969) (mimeo), VPI.

[9] Paul W. Hamelman, " A Cost/Effectiveness Approach to a University Planning Problem," The Bulletin, Operations Research Society of America, Spring 1967.

[10] West Virginia Committee on Higher Education, Higher Education in West Virginia -- A Self Assessment, (State of West Virginia, Charleston, October 31, 1966).

[11] Dennis R. Leyden and Vance Q. Alvis, "Fiscal Imperatives in 1975," (West Virginia University, Bureau of Business Research, Morgantown, 1968), p. 26.

[12] West Virginia Commission on Higher Education, A Demographic Study for West Virginia Higher Education," Part II, Projections, (Commission on Higher Education, Charleston, 1967), p. 16.

[13] Comparable public costs per college graduate among other states are not generally available. However, in California the cost differences between institutions in the University of California and the Public Colleges is the opposite of the West Virginia experience. It costs the State of California $9,210 in subsidy per graduate among the universities; $7,780 per graduate for the four-year state colleges. See Werner Z. Hirsch, "The Budget as an Instrument for Medium- and Long-Range Planning and Programming in Education," (OECD, Directorate for Scientific Affairs, Paris, 1968) (mimeo).

[14] Subcommittees on Higher Edication, "A Study of State Institutions of Higher Education in West Virginia," (State of West Virginia, Charleston, 1968), p. 38.

[15] Some insight into the effect admission requirements have on student survival rates is found by comparing resident student performance with non-resident students in the same colleges. The public colleges follow an open door admission policy in regard to West Virginia applicants; a high school graduate need only be in the upper three-fourths of his graduating class for acceptance. Non-resident enrollment in the state colleges is, by State policy, restricted to not more than twenty percent of total enrollment therefore, the colleges are more selective in admitting non-resident applicants. One consequence of the dual admission standard is the significantly greater ability of out-of-state students to survive graduation from West Virginia colleges than residents of the State. This characteristic is a consistent one in each public college. West Virginia Commission of Higher Education, op. cit., p. 16.

[16] Jacques Barzun, The American University, (Harper and Row, New York, 1968), p. 114.

EDUCATIONAL RESOURCE MANAGEMENT

William Curtis

The presentations which I will be making this morning will be divided into two sections. In the first one I will deal with planning, programming, budgeting, evaluation, system design as a new approach to decision making in education. As a part of this first presentation I will identify some of the problems and the more promising practices thus far developed. Finally, I will attempt to set the stage for the second presentation which will be illustrated. The second presentation will deal with a conceptual design for the application of this concept to education as we see it today. I would call your attention to the fact that some of the materials in your hands relate to many of the things I will be saying this morning and are covered fairly well in the document.[1] I will try to relate to that document wherever possible.

I think that perhaps I ought to take just a few minutes to explain the background of the project with which I am connected. It was the presidential mandate of 1965 which called for the application of the PPBES principle to all segments of the federal government. This mandate called for the development and implementation of this concept within the framework of the various departments at the earliest possible moment. From this mandate and from a developing interest on the part of the Congress, which has now spilled over into the legislatures, the governors, and by and large our constituency, we find great pressure being grought to bear to apply this concept to the world of education at the state and local levels. As a result of this influence, about three years ago the U. S. Office of Education indicated that it would consider proposals which would deal with the application of this concept to state and local levels of education. As I understand the history of the submission of the proposals, sixteen were submitted. None proved to be entirely satisfactory to the U. S. O. E. but the two which seemed to be most satisfactory and which had considerable potential, in their judgement, were the ones submitted by the Dade County Public School System of Florida which includes Miami, and by the Research Corporation of the ASBO. Consequently representatives of the two groups were called to Washington and it was suggested that their proposals be re-written and that the two groups, namely Dade County and the Research Corporation, join in partnership in a proposal. About two years ago agreement was reached on a joint proposal involving the two groups, and it was funded in the spring of 1968 and work was begun the summer of 1968.

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[1] RC-ASBO National Proceedings, June 1969.

The basic responsibilities of the Research Corporation of ASBO are threefold. First, we have the job of surveying and analyzing information on program budgeting activities across the nation. Second, and probably most important, we are responsible for the development of a conceptual design for planning, programming, budgeting, and evaluation, for local school systems. We have the responsibility, prior to June 30, 1971, to present a conceptual design which hopefully will be applicable to the local school districts of the United States. We have a third charge which is also very important: the dissemination and publication of project results across the nation, including state and local levels. Dade County, our partner, has two basic responsibilities: (1) the development of an evaluation design for planning, programming, budgeting, evaluation, for the Dade County school system, and (2) the implementation of the system once it has been developed.

We have, I think, made considerable progress in the study of what is happening across the country and in my initial presentation this morning I shall try to share with you some of these happenings, both good and bad, and give you some idea of where we stand. We do have the basic schematics for the conceptual design and these schematics will be presented to you in the second session this morning. Because our year of dissemination and review has now been completed, it is going to be possible for me to share with you, as I "walk" you through the design this morning, the areas in which people in the field feel that we should make changes in the basic schematics.

I thought that before I dealt with some of the problems, it might be well to amplify some of the factors tending to bring some phase of this concept into the field of education. I am going to assume that there is a reasonable degree of sophistication as far as the PPBES concept is concerned. Therefore, I am not going to spend time on historical background. Don Levine, one of our research associates, has prepared a speech which does deal with the historical aspect of PPBS in some depth and a copy of his speech has been given to you.

I have identified a few factors which I though would be worth mentioning, factors which tend to bring some phase of this concept into education. I begin with what I call the current financial crisis, as it relates to public schools and coupled with it, the demand for better long-range planning and to give greater consideration to the manner in which we identify and handle our resources.

The second factor is the growing voice of the public which is demanding improvement and change in the budget making process. I would make the observation that in spite of the known integrity of educators, as well as their competency in business affairs, the present system under which we are operating makes it difficult to convince the public that schools are being run with reasonable effectiveness. I am talking about what you and I have known now for some years as the line-item, function-object approach as we have developed and presented our budgets to the public. This approach has served well over a good many years, but it has become inadequate and as more resources are being allocated to education, the public is demanding a more thorough accounting of expenditure procedures and I think the public feels that some phase of this PPBES concept may be the answer.

A third factor, one which is very real to all of us, is the rapidly changing pattern in the relationship between local, state and federal financial support. I do not need to review with you in depth, the rapid change which took place right after World War II. You know that state support increased rapidly and has continued to increase. Now in the last decade, and especially the last five years, we have seen the growing involvement of the federal government. As more state and federal money has been put into education, we have found a greater demand on the part of the legislators and the Congress for more accountability and again, because evaluation and planning are integral parts of the concept, they feel that perhaps the application of PPBES represents a solution to the problem.

A fourth factor is the existing serious inequities in the financial support of the public schools. I remind you of the rapid transfer of the high degree of affluency which prevailed in the cities a few decades ago, to suburbia. Related to this transfer are the great problems we find in the cities, the crises the cities are facing and the comparatively small amount of aid which the cities are being given in relation to their needs. I would also note as part of this problem of inequities the tremendous imbalance in resources state by state, which in themselves have created very serious inequities in educational opportunities in this country.

There are many other factors which could be listed, but I thought I would give three or four just to indicate why some of these pressures seem to be growing.

For the next few minutes I will continue to reflect the negative side because I would like to share with you some of the major problems which are being encountered structurewise, especially when we try to lay the foundation to apply this concept to the field of education. I can't begin to tell you how complex this assignment has turned out to be, and part of the complexity, I am sure you realize, is due to the fact that we are dealing with human beings and not inanimate objects. As a result, we are having some problems, especially in getting a grasp on the evaluative aspect. Incidently, these problems I have listed for presentation to you are not necessarily in order of importance or impact.

The first problem deals with the matter of what some people call program budgeting. You will note in the bibliography that some of the titles are under the heading of program budgeting. Others use the total monograph. (Some people call PPBES an acronym, but I think technically it is a monograph.) Thus far we find that a great deal is being done in the name of program budgeting as such, but little in the true PPBES approach. I shall be very deliberate this morning in trying to differentiate between program budgeting as we see it and the application of the planning, programming, budgeting, evaluation, system design.

We find basically that planning and programming, or program planning, whichever you choose, and evaluation are being neglected. Probably there are good reasons why they are being neglected. Although you and I as educators have done considerable planning in the past it would appear as though we have never done a total job in planning especially with that part which deals with sound, long-range planning and which involves all segments of our operation. It would appear as though we have not always developed our plans and our programs based upon our fundamental needs and problems. In other words, we have accepted programs in our school systems because it has been traditional to do so, but too often we have not gone back to take a good hard look at our needs and problems before we have completed our plans and before we have developed our programs. Consequently, we find that the school districts which claim to have applied the PPBES concept, thus far have merely taken their existing operations and translated existing programs into what is known as a program budget. There has been no basic planning; there has been no study of needs and problems; there has been no change in the programs as a result of these efforts; and furthermore, there has been no real plan to evaluate the accomplishments in terms of established objectives.

I think you will be interested in three surveys which we conducted a little over a year ago. First of all, we conducted one to try to determine how much is being done in this particular field. Out of 3000 questionnaires which were sent to the ASBO membership we received approximately 1700 completed returns. We studied these very carefully, and we found about 100 school districts across the country, which in our judgment, seemed to be applying some phase of the PPBES concept. We then prepared a more comprehensive survey and sent it to the 100 school districts. We were trying to determine whether these school districts had actually applied this concept in total. After we had reviewed the returns of the second questionnaire, we selected 23 districts which still seemed to us to have applied some phase of it. Then we investigated these 23 districts more carefully, and when the work was completed, we found that not one single district in the U. S., as far as we can determine, has actually designed, developed, and implemented a complete PPBES system.

Now, please do not quote me as saying that nothing has happened. Much has been done, much experimentation is going on in many districts. We think we know most of them and we feel that good work is being done. There are segments of the approach being applied in many individual districts. But this business is so complex that it is going to take school districts many years, in our opinion, to design, develop, and implement this concept. Again, much is being done in program budgeting and several districts are now beginning to approach the total concept. There are many hopeful signs on the horizon, but this matter of planning and relating programs to planning and the evaluative aspect still present major problems.

The second problem, and one which I hope will strike a very responsive chord, particularly with the curriculum people in the audience, is keeping the focus on the learner and what takes place in the classroom and the importance of keeping the instructional process in the forefront in the development of the design. This comment causes me to make another observation. Too many persons, in our opinion, are looking upon this concept as a new budgetary procedure and too much emphasis is on the budget. Budgeting is an integrap part; budgeting is a component of the total concept; but in our opinion budgeting is not necessarily one of the most important components. Fundamental planning, fundamental programming, and evaluating are much more important.

The curriculum people. those concerned with the instructional process, in our judgement, should have key positions of leadership in the design, development, and implementation of this new approach to 1the decision-making process. I can't begin to tell you how many persons have said to me, "I should have no trouble applying this concept because my major field is finance," or who have said, "We are specialists in computerization and we know this concept involves computer applications so it shouldn't be too difficult for us." Nothing could be further from the truth. It is true that the computer ultimately will be of great value in helping us to expedite the implementation. The computer represents a tool but not an integral part of the overall concept.

The third problem, and a very critical one, is the pressure to bring forth the PPBES design now and not two or three years hence; to release information prior to the time when concensus has been reached on the major issues and developmental process; to produce pat answers on all segments of the process and in other words to produce the so-called "black box" or a "cookbook." Such is not our assignment. Our responsibility is to develop a conceptual design from which the school officials of this country can begin to design and develop and implement the process within their own districts. In our document we will try to give examples of "how to," but we refuse by virtue of our contract, and also by virtue of our philosophy, to bring forth the "cookbook." We feel to do so would be the greatest mistake we could make as we begin to lay the foundation for the application of this concept to education.

There are many misunderstandings as to what this concept will do and as has often been said, a little knowledge is a dangerous thing. Much of our constituency outside of education has read about PPBES and has latched onto it as something pretty special. Many persons seem to think that this approach will prepare a pathway to cheaper procedures in the world of education. It will not. Hopefully it will help us to take a harder look at our needs and problems. Hopefully it will make it possible for us to identify and do a better job of allocating our resources and hopefully it will bring about a better means of accountability, but it will not as yet present a cheaper approach. We have been quite certain of this point right from the beginning of our efforts. However, because so many persons in our constituency, outside of education especially, have read about this new approach and because they think it is the panacea, the pressure is on to bring forth this design now and apply it. I have had several calls from persons, especially at the state level, and some of them have called almost in panic. For example, one person referred to a call from a governor's office, another from the chairman of a legislative council and in each call they said they felt this concept is fine, and why not go ahead and apply it immediately. One man said he received a call on February 1, and was given two months to design, develop and put a program into operation in his state. This man said all he needed from me were all the reasons why he could not meet this request. The job just cannot be cone in so little time. It is a matter of three to five years in our opinion, and maybe more. But the pressure is on, and it is pretty difficult sometimes to resist the pressures. I can't begin to tell you how many times I have been asked to arrange for duplication of the slides which you will see very shortly. People wish to take them and use them, even though we have told them we are going to make some drastic changes in them in the next 30 days. They still want them as they are because the pressure is on them to produce immediately.

The fourth problem is the failure still, on the part of so many leaders in the field of education to realize and accept what is taking place. At present it would appear that there is more reticence on the part of the chief administrators, both at the state and local levels, rather than on the part of the school business officials. There is apprehension, but this apprehension is probably due to a lack of understanding of the concept. I am glad to say this picture is changing; changing as a result of dissemination efforts on the part of several groups including ours, but there is still a lack of understanding in our country. Our constituency outside the world of education, at the moment, in many instances, is in the vanguard.

There also seems to be a fear on the part of some educators, that this new process will unveil too many weaknesses in their administrative patterns and I expect this situation may prevail. It will bring out weaknesses; it is bound to do so, just by the very nature of it. However, I submit to you that any administrator of stature certainly should be willing to accept these weaknesses as they are identified and do something about them and as a result build a better system.

Number five, very simply, is the problem of just plain everyday resistance to change. In other words, we have done it this way before, it has worked pretty well and so why bother us with this complex business. Such an attitude may be acceptable for some persons, but I do not think our constituency is going to allow us to rest. I think we will be asked to apply some phase of this concept to the decision-making processes in the very near future.

Number six, which I'm glad to report is diminishing rather rapidly, but which for a while has been a problem, is the lack of coordination between various projects across the nation. USOE policy does not call for tight coordination of effort on projects of this type, primarily, as I understand it, because the Congress is always afraid of being accused of federal domination. However, the project directors across the country have gotten together informally and there is a much greater sharing of information. I am delighted to tell you that the cooperation between project directors has been very good and it continues to improve.

The seventh problem is the one which I have called an almost involvable problem. It is the problem of satisfying each of the 50 states. In support of my listing of this particular problem, I offer the following thoughts . I would remind you, for example, of the variance in the state laws and the reporting processes. Also I would remind you of the great variance in state support programs and state formulas. I call your attention to the varying degrees of fiscal independence and fiscal dependence and the varying size and characteristics of the different school districts along with their wide range of educational needs and problems. When you put all of these variables together and you think about the assignment of developing a single conceptual design that will be applicable to meet all of these requirements, you can understand why I might wish to just leave the project. However, we still have a commitment; but again as a reminder, it is to be a conceptual design and not a "black box." There has to be a high degree of flexibility in this design so that we can maintain the fundamental rights of the individual states and reasonable autonomy of the local districts.

For the rest of the presentation I will try to be more on the positive side. Let me recall just a few of the more promising happenings and also a few of the areas of consensus to date. Communication and coordination among the project directors; communication between states; communication between the pilots districts, our partners and other districts which are working on this concept gets better all the time. Such is all to the good because we need to share this information fully.. Writing, research, and study is on the increase and each month as I read new articles and talk to the people involved in research (a number of men are doing their doctoral studies in this field and we are cooperating with them), I find there are increasing signs of greater responsibility in reporting development. (Incidentally, I should tell you that this design itself represents the basic efforts of a doctoral study on the part of John Gott at Washington State University.)

There are signe of increased support and interest in all segments of government. I think you will see how much emphasis is being given by the USOE and the office under which we operate, the National Center for Research at the Elementary and Secondary Levels; when I tell you that thus far, ours is one of the very few projects funded for 1970. Such will indicate the importance the government is placing on the application of this concept.

We are getting much better support from the professional organizations and from the institutions of higher learning and at this point I will make this observation. I think that for the in-service programs needed, the institutions of higher learning are going to have to accept prime responsibility.

Finally, we are getting better support from influencial segments of the public which are trying to understand what this concept is all about. Hopefully, they are going to give us some time to get the design developed properly.

We are finding that there is more recognition on the part of administration and boards of education that this new approach requires the involvement of many more persons in the planning, developmental and decision-making process. No longer is management of education a unilateral process. The application of PPBES concept calls for broad involvement at all levels well beyond the central office.

As far as consensus is concerned, we have an agreement on a joint rationale, we have consensus and support for the design itself. When it has been developed we have agreement that it must be very flesible and suitable for small, medium and large districts. We have consensus that there is a great need to indoctrinate everyone in the importance of reaching agreement on basic goals and objectives to be achieved initially, coupled with long-range planning. These points are fundamental to the application of this concept. You and I know that for too many years we have operated on the single year approach in our own allocation of resources. Also any additional resources allocated to us usually have been on a percentage basis and on the basis of political expediency.

We have consensus that the conceptual design must reflect a pupil centered character with emphasis on the learning process and as you look at the design with me later on, I hope you will note whether we have captured these points of long-range planning, multi-year approach, focus on the learner and what happened to him in the learning process.

We have consensus that evaluation as it relates to the degree to which the objectives have been attained will continue to be our most knotty problem. However (and this is very important to you people who are specialists in evaluation), we are in agreement thus far that not everything can be quantified and that there will still be a rather high degree of subjective measurement as compared to valid accepted objective measurements. Now, please do not leave here and quote me as saying that we are going to do away with objective measurement procedures. Of course, having established basic objectives and enabling objectives as part of this concept, wherever we can measure such by valid, accepted instruments, then certainly we support this practice. But we do also recognize that subjective judgements are going to be very important in the evaluative process. Therefore, in the design we have tried to point out that evaluation is a two-way street, subjective as well as objective in nature.

In conclusion I would like to share with you a few fundamental points and principles which we feel must be considered in the developmental process. Again I shall be rather deliberate in presenting these to you because I wish to imprint them in your mind and then later on, have you look to see whether we have captured the application of these points in our schema.

First I would emphasize to you the importance of building initially from resources, and encouraging the staff and others to think in terms of resources as people, materials, environment, time, values, with dollars as a means of procuring these resources. I'm afraid that too often we think of resources as dollars only, and I'm afraid that down through the years we probably have neglected too often, the effective application of our most valuable resource, people. Obviously dollars have to be considered. However the point I am trying to make is the consideration of resources in the braodest possible sense. At this point I must emphasize the very important part which administration must play in the identification and effective utilization of resources and encouraging others to do the same.

There seems to be a consensus that the design itself should lead from an examination of resources to the development of and the determination of the relationships between objectives, programs, processes, and evaluative procedures. There seems to be an every increasing need for stronger and more effective leadership at all levels in the planning programming process. This process will include not only the identification and acceptance of major objectives, programs and processes, but also sub-programs, sub-objectives and alternatives available to all involved in the decision-making process.

In summary, I have talked about long-range planning, about the identification and allocation of resources, the establishment of objectives, the establishment of sub-objectives, the development of programs and sub-programs and the accountability factor all as part of the application of this concept. In re-emphasizing these points again I am trying to get away from the straght program budgeting aspect. There is much more to the process than just applying a budget to existing programs.

There seems to be agreement that this modern approach to the development of an educational resources instrument must have as its focal point the instructional process and what happens to youngsters. Here again there is an implication that administration at all levels has a prime responsibility for professional leadership. It must be remembered that PPBES represents a management system and not just a budgeting system alone. It is a management system and we are moving even now toward discontinuing the use of the monograph of PPBES and moving into the Educational Resources Management Design concept. It will involve details. It will involve the sifting of information and the consideration of options for effective use of resources and evaluation. Alternatives is the name of the game. PPBES or ERMD offers a means of organizing this information in an orderly fashion. This statement causes me to stop again and remind you that I know you have been doing some of these things in your school system. There has been some planning; there has been some programming; there has been some evaluating. But have all efforts been organized into a total system which begins with a hard look at your needs and problems and involves long-range planning, development of suitable programs related to this planning and these needs and problems, resource allocation according to a plan, and evaluation to introduce the accountability factor. It is a total system we are talking about. It offers an opportunity to move the decision-making process down the ladder in varying degrees of responsibility.

You will have an opportunity to see a series of schematics which illustrate the Research Corporation of ASBO's Educational Resource Management Design as developed to date. As you view this design, I would like to solicit your opinions as to whether you feel our initial effort has encompassed the previously mentioned concepts. As I indicated to you earlier, because we have completed the dissemination and feedback process for the readiness year of 1968, I will be able to share with you in the next presentation the compilation of feedback which came to us concerning the written document which we must not prepare and are in the process of preparing, in support of the schema itself.

This is the introduction to the conceptual design as we have put it together to date. It applies the PPBS concept to the field of education. I have given you quite a bit of background for this presentation, so I am going to move right into the design itself. As I told you, it is our charge at the end of the project to present to the U. S. Office of Education a conceptual design. What you will see here today is the skeleton of this design as we see it now.

Chapter 2 of the first section of the document is 95% completed. This morning I mentioned the name of John Gott, who is a graduate student at Washington State University. He has developed his dissertation around this idea, and I wish to make certain that he gets a large share of the credit for the development of this design. He has had the help of the team, and we have all worked with him; but he has been the prime mover. Copies of Chapter 2 have been turned over to the other writers. We have taken Chapters 3, 4. 5, and 6 and built those around the major processes. Dr. Bliss is responsible for the leadership on Chapter 4, Programming, as well as having responsibility as a consultant. But as he would be the first to tell you, he is not operating alone. Programming is part of the whole picture and the writers must coordinate their efforts.

Let me go back for a moment to Chapter 1. You will remember this morning I emphasized change to you and I emphasized environment and the School's responsibility to the society to which it serves. So we have entitled the first chapter "Society's Expectations" because it represents a look ahead. Chapter 7 deals with necessary organization and reorganization within a school district, as well as in-service educational programs. Chapter 8 deals with interstate and intrastate problems. Chapter 9 deals with implications for the future. I won't take time to tell you about the other writers unless, after the discussion, you are interested in knowing who the other writers are. I can assure you that we have put together an outstanding team because we have been able to persuade some of the outstanding leaders in the country to participate in the development of this document.

As you look at the screens this afternoon just remember that what you are seeing is the backbone of Chapter 2 which is being developed in depth along with Chapters 3, 4, 5 and 6. There is a complete interrelationship between all of them. Section 1 is the backbone of the document. We hope that it will be written in such a manner that you people as school superintendents and your board members and your teachers can take this document and find it readable, not too highly technical, and from it we hope you can glean the guidelines for applying this concept for your particular district. Because there has been considerable pressure on us and I think rightfully so to do something more from the standpoint of the "how-to" approach, we have added a second section to this document which will deal with the "how to." Just recently we have contracted with a firm of specialists in the field of systems analysis. This firm has reviewed our design and the firm members feel that they can do a job for us. Therefore they are going to take our design, and with the help of one of our research associates who is a specialist in systems analysis himself, they are going to, in his words, "put some meat on the bones." They are going to take this conceptual design as we have developed it and expand it on the basis of resources analysis and overall systems analysis.

In addition, we think we would be remiss in our document if we did not say something about the area of PERT, MIS and similar techniques which are comparatively new to the field of education and which will have a relationship to our design.

I told you earlier that we have a partner in Dade County. Dade County will give us a certain amount of feedback in the form of recommendations, especially as they might relate to the program structure as well as performance. We have seven pilot districts as well as Dade County which have been in the process of testing various segments of the design. We expect that they, along with Dade County, will give us very complete case studies. These studies should not place constraints upon you as school administrators but hopefully will give you guidelines and ideas for the application of the design to your school district.

Thos of you who are experts in the field of school finance, and, of course, all of you as school administrators, are familiar with the handbook series of the U. S. Office of Education. I assume that all of you are aware of the fact that Handbook II is now in the process of being revised. It will be completely revised by June 30th of this year and will be distributed in rough draft form for consideration by selected school administrators during the next school year. From the beginning it was apparent to us as it was to the U. S. Office of Education and the Handbook II contractors that there must be complete compatibility between what we are doing and what the contractors are doing in revising Handbook II. I can assure you that we have had fine cooperation from the U. S. Office of Education and the con tractors. Evan as late as last week, I met with the national committee. We reviewed the handbook especially as it might have compatibility with our design. In the time allotted to me today I will try to show you, part way through the design, how the cross walk between our design and the handbook will be accomplished. I will try to show you in capsule form how the theoretical will be translated to the practical.

There will be one other segment of the second section which will deal with the matter of attribution. However, this issue is so far in the future that I hesitate to say anything more about it. Also, we have developed a new glossary in relation to the design itself. We are trying to keep the definitions comparatively simple.

I am now going to walk you through the design step by step. Because you have quite a bit of reading to do, I will be rather deliberate.

The question has been raised as to why we place a developmental contract on something which is within the public domain. The answer is comparatively simple. This is a U. S. Office of Education project. The U. S. Office, of course, would be expected to have prior rights to it, and it is their recommendation that we cover it with a developmental copyright. And, of course, the Research Corporation of ASBO has a special interest in this document and feels that it wants its rights to be protected.

There is another reason. The demand is so great for this national design, whether it be ours or someone else's that a great many persons who wish to serve as consultants who would like to have it in advance. There are many school districts which would like to have it in advance. We think this would be a mistake because it is still subject to revision, and we are still getting test results from our pilots and there are still some revisions to be made. We feel that to distribute it now on a widespread basis would be poor judgment.

I indicated to you this morning that we had decided to change the title. I will take just a moment to give you the rationale behind the title as we see it. We felt that because this design will be influential in the field of education we should call it "Educational Resource Management." Because it affords proper identification and allocation of resources which are so important, we felt that these should be included in the title also. It is management technique and hence the introduction of the word management in the title also. We may drop the word design from the title ultimately.

Some of you know Dr. Steven Knezevich, the Associate Secretary of AASA. He is one of the specialists in this field. He told me recently that at this year's National Academy Clinics PPBES has proved to be the number one topic along with teacher evaluation and general evaluation. I mention Steve's name particularly because he feels the title of this concept should be RADS. In his new book he talks about Resource Allocation Decision Systems (RADS). Regardless, we are getting away from a title that tends to deal with inanimate objects and suggests that we are dealing with human beings.

Slide.* From the beginning we decided that perhaps there ought to be certain assumptions called to your attention. I have set the stage for walking you through the design at various levels. As you read it, I would remind you of something I said this morning. More and more as you get involvement from your staff and your constituencies your programs will expand. As a result of greater involvement your resources will never equal your demand and consequently you have the stage set for the study of priorities.

Slide. Those of you who are familiar with the PPBS concept will remember at the top level you will deal with three processes: inputs, processes, and outputs. For the next few moments I will be talking to you at that level and the application of these processes to the field of education. You will note that almost immediately we emphasize the learner.

Slide. Objectives of the school system. Once again we are introducing a few of the phrases which I talked about this morning: the matter of strategy, program strategy, matter of effectiveness and the question of alternatives. I repeat, alternatives if the name of the game.

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*The diagrams in the slide presentation will be made available at a later date by RC-ASBO.

Slide. Productivity of a school system. I will stop at this point for just a moment and call your attention to a phrase in the middle of the assumption. It deals with the organization of learning activities and support services. You will see later that we define a program as a configuration of learning activities and supporting services. If you will imprint this point in your mind as we move through the design it will be helpful because we will be referring to it time and again.

Slide. An important point to emphasize is the matter of long term planning and that the greatest benefits result when the costs are considered on a multiyear basis.

Slide. Final assumption. Once again this particular assumption attempts to put together in capsule form that top level of the PPBS concept which includes inputs, resource allocation, process, outputs or outcomes--the relationship between outcomes and the objectives which you have established for yourself.

Slide. You will remember in the repetition part of my presentation this morning I was talking about resource management and some of the definitions. In one instance, I referred to the environment of which the school is a part. You will remember that I made reference to the school and its responsibility to the society which it serves.

At this point in the design we are trying to establish a relationship between the school and society. And so we have placed the school as an integral part of society. We felt in the original diagram we should show that it is a strong part of society which it serves.

We derive these inputs from the society. Identified on the right hand screen some of these inputs (resources). Again let me remind you that dollars are the means of securing these resources. If you, for example, choose to place dollars as a resource also, certainly this is your decision.

These resources are turned over to you and to me as educational administrators and it is our responsibility to use these resources effectively. From these processes we have the outputs which are represented in terms of specific growth on the part of the learners. I would call your attention to the right hand screen and the last item--attitudes. This causes me to remind you that there should be not only objective measurements but also some subjective measurements as well.

Slide. There is a reason for the colors. If you would cement those in your mind's eye it would be helpful because as we move through the design we will set forth a series of group codings. You will notice that even though we have changed the name of the design, we have not set aside budgeting. Last fall the leadership said to us, in your original diagram you have not adequately shown that this concept is an on-going process nor have you reflected the re-cycling idea as strongly as you might have done. You need to emphasize planning as well. So in the new diagram instead of the pie-shaped one some of you may have seen, we have developed a new series of illustrations. I call your attention to the double arrows. These reflect an on-going process and each component is an integral part of the whole. At the same time re-cycling is emphasized also. As you will note, all are built around decision making because the design represents a new approach to the decision making process.

Slide. Definition of Planning. Now to set the stage for the next level. We will be walking through the activities and events of each of the components. I will give you just a moment to read each of the definitions that we have on the screen. Again, I emphasize that change is one of the most important words to consider in this design.

Slide. Definition of Programming. Here I am repeating what I said a few minutes ago that a program represents a configuration of interrelated learning activities. We have introduced a new statement at this point when we are talking about an enabling objective. In this design we will be dealing with overall goals, general objectives and enabling objectives.

Slide. Definition of Budgeting. Admittedly the next definition is a little bit complex. We decided to get all of the points into it so I will give you a longer period of time to read it.

Perhaps more important than anything that is said in the definition on budgeting is the fact that prior to this point in the design we have dealt with planning; we have dealt with the consideration of alternate strategies; we have dealt with programs involving both learning activities and supporting services; and we have dealt with the identification of resources and allocation of resources. All of these steps have taken place before the budget process. I cannot emphasize this point too much. In other words, it identifies a new role for the curriculum specialist, middle management and certainly for you, in a sense, as chief administrators.

Slide. You will find us introducing this slide time and again primarily to remind you that each of the components of the design are all interrelated and all of the activities in each component end up as part of the overall picture.

The next series of slides represent recommendations by the leadership last fall. They said: You need to include more in the way of detailed activities, which in themselves can be expanded upon in a school district by your professional teams. What you are about to see now represents the skeleton of a series of activities which we think you could follow in implementing aprogram in your school district.

Slide. First of all, activities and their definitions. Activities terminate in an event. We introduce a very simple definition of the event itself.

Now we are ready to move into the planning process and its activities. May I remind you that from this point on we are talking about the strong relationship which exists between the school and the society of which it is a part.

Slide. You suggested that we begin not only be identifying these activities, but by trying to illustrate them through three dimensional models. The question has been asked of us, "What do you mean by task force plans?" For example, one of our pilots, which has been operating now for a year and a half, organized a task force of approximately 40 persons. About 15 members of the task force were members of the professional staff. They had 4 or 5 students on the task force. The rest came from the community at large. The administration and the board tried very hard not to have the task force made up of persons who always volunteer. It was a real effort to have the task force made up of all segments of the community so that the planning effort would be truly related to the needs and problems of the district.

I do not feel that the task force should be extremely large. We have them ranging anywhere from 30-60. I think the California project has 14 pilor districts and they have indicated that their task forces range anywhere from 25 to 100.

Slide. I said this morning that the field has suggested that we must consider early the identification of resources and problems so we placed this as one of the first activities after the task force is formed. You cannot establish goals and objectives until you have taken this first step. Over here on the right hand screen we have tried to illustrate this idea in a three dimensional model. The relationship on the left suggests that it should be considered at all three levels--local, regional and national. You will note the long term approach.

Slide. I will give you a moment to read these four activities on the left hand screen and then offer a comment. Please note the words that were emphasized this morning: goals, priorities, resources, analysis. And over on the right hand screen in the three dimensional model we are suggesting that analysis is one of the important features of this whole process. More sophisticated resource analysis will be handled just a little bit later on in the design.

Slide. The salient features on the left hand screen of this particular slide: The broad statements of responsibility and such of course refers to the matter of broad or general objectives. In other words, in the previous slide we selected broad goals. We can now move into the selection of general objectives which is one step below broad goals. We have covered the idea of analysis and selection of broad goals. After we have taken these steps we are ready to transmit the recommendations from the task force to the board of education for review and adoption.

Two points in connection with this particular part of the picture. Obviously we would not, should not, and could not overlook the responsibility of the board of education. This leads me to say that all of our pilot districts and all of the California pilots and others across the country have always had representatives of the board of education of their task forces. It is most important with all the hard work for overall planning being done by the task force, to have strong lines of communication from the task force to the board and return. In the final analysis the board of education, the properly constituted authority, makes the final decisions on the recommendations which the task force sends to the board for consideration and final action.

Slide. This morning I said that re-cycling is important. I said it again this afternoon when I showed you the basic diagram. I indicated that re-cycling is essential within a component as well as re-cycling in the overall process. Why? Because there will be change. The needs and problems will change. The resources will change. The capability of the school system will change. As a result of these changes there should be re-cycling in order to insure an on-going process, which is responsive to the society which the school serves.

Slide. Again this reminder that even though we have just walked through planning and its activities it is still part of the overall picture.

Slide. We are now ready to take you through the next process, that of programming. The statement on the right hand screen is merely a reminder of what we mean by programming. Programming does consist of a configuration of interrelated learning activities and support services. On the next slide you will see the relationship I am sure. One other item i.e., the point in the process where the professional staff takes over. I am not suggesting that the professional staff does net have a responsibility in the task force but it assumes a much greater degree of responsibility at this point.

Again the question has been raised of us, "What do you mean by professional teams?" How many should be on a team, what should be the make-up of the team. Our document will give you examples but our document will not tell you as professionals how you should put together your own team. We will try to establish ideas and guidelines but we think the final determination of this matter is yours and yours alone.

The general objectives having been established by your task force, are now turned over the programming teams for further action as illustrated in the next few slides.

Slide. The major point we are suggesting here is that you can usually determine more than one way to accomplish the general objective. There may be three or four ways available to you. There may be even more. Again--your decision. The question has been raised of us, "Will you give us examples of general objectives?" The answer is yes. However, we did remove one slide from the last set last fall in which we had specific examples because we found that merely by suggesting terms which might possibly serve as an example of goals, persons were tending to say that we were promoting the Imperatives of Education as major goals. This morning Dr. Bliss made several references to the Bloom taxonomy. I expect that now Dr. Bliss will be the person who will be identified as supporting Bloom's taxonomy as the basis of overall goal determination. So we have purposely left that slide out but in the document we will give examples from the case studies from our pilots. Thus far one of the best sets of overall goals and general objectives written by one of the districts (not one of our pilots, by the way) was one in which the staff and task force sat down together and determined what they should be in terms of their own current needs and their problems.

Slide. This is the point at which we introduce this matter of alternatives. The question has been raised of us, "What do you mean by alternate program strategy?" For example, we might take one of the most common ones. Suppose that your task force has agreed that one of the overall goals of your community and your school district would be to make your youngsters more literate and much more skilled in communications. From these objectives, your professional staff prepares a series of specific objectives or enabling objectives for carrying out these general objectives. Again your staff is faced with the problem of how to go about doing the job.

Slide. Through these pyramids you can see illustrations of different numbers of alternatives that might be avaialble within a combination.

Suppose some segments of your professional team said we think these objectives can best be accomplished by reduction of class size. Another group may say we think our problem is at the early levels. We need to offer something more in the way of preventive services. You may have a group of teachers at the junior high level or middle school who say we have youngsters with reading problems and we need to correct this by bringing in more remedial teachers. Then we may have a third group which is looking ahead and say that so much has been done in the way of new technology that we ought to spend more money on some of the newer reading equipment or materials. Finally, there may be another group who says we need to compromise and utilize segments of each of each of these ideas. Thus you have an example of the consideration of alternatives.

We have talked about various program strategies. You may say that you follow this procedure now, but the question is, do you do the total job. Do you do it on the basis of the long term plan, the broad planning that we are talking about, the establishment of long term objectives, and do you look at all of the alternatives available to you.

Slide. You will notice that we have added a slide on the right hand screen which deals wit halternative strategy selection and analysis. In other words, you begin to look at effectiveness. You begin to screen, you begin to analyze. You begin to pay attention to this idea of cost effective analysis. You look at the benefits. You look at some of the constraints in terms of resources available to you, constraints in terms of time, constraints of political attitudes. On the other hand, the benefits may not be as great in terms of the time and money you must spend. So you analyze and select the optimum program strategy in line with your resources and potential benefits. We have been criticized for using the term optimum. We have a recommendation that perhaps we ought to use the word preferred. Regardless, we take this configuration of strategies and put them together into the programs. Programs, as I indicated before are a configuration of learning activities and support services.

Slide. Again we remind you that re-cycling within the component itself as well as re-cycling within the overall process is very important. Again let me emphasize the very important role that the persons concerned with instruction and the learning process play in planning and programming. Although your business officials will, to some extent, be involved in resource allocation, the responsibility for such now rests primarily with the instructional staff and not with the business staff.

Slide. Again the reminder that the definition of budgeting as you saw it a few minutes ago. I will give you a minute to read each of the next few slides as we move along and I will offer only a comment or two on each. It has been most interesting to us to note that each of our pilots and pilots of other projects, as they have gone about the business of testing our design, has felt the need initially to examine its organizational structure. Each district has told us that they have had to do some reorganization in order to apply the concept.

Slide. Now we have moved into the budgeting process which we are going to call both budgeting and resource allocation. Your business official and your business department from now on need to know far more about the instructional processes than they have ever known before. Related to this same point, your instructional people must know far more about the business process than previously.

Slide. Nowhere have we suggested that you set aside the budget format. However, we are suggesting that the budget format of the future will look far different from the one you have known. I can tell you from the revision of Handbook II that the present budget format starting with administration as the 100 category, instruction 200, etc., will no longer be the pattern in Handbook II. Therefore, in a year or so you would do well to get ready for an entirely new approach which will be compatible with this design.

Slide. Again I would like to remind you that resource identification and the development of programs and analysis and application and allocation of resources according to a plan has been almost completely determined prior to the budgetary procedure. Resource allocation, although it takes place at this level to a limited extent, has already been decided for the most part in the planning, programming process.

Slide. Again I remind you that we are not forgetting the responsibility of the board of education. The board of education does have the final decision so far as the budget document is concerned.

Slide. The question has been raised of us as to why we put that second statement in the list of activities. Those of you who administer fiscally independent districts probably do not have to be concerned. However, in quite a few districts the school board has to answer to an authority beyond itself. Because this is true, we felt that this statement should be in there with the notation "if required."

Slide. I have no particular comment to make on this slide. I think I have emphasized enough the idea that we will utilize these resources and support services, all of which will lay the foundation forthe slides which you will see in just a moment.

Slide. Again the emphasis is on re-cycling.

Slide. We have done a great deal of soul seraching in our study of the accounting structure, and we have been in close communication with the leadership including discussions with board members. From all of these people we have tried to determine. . .how many classifications the constituency really needs. I am not only talking about our boards but our communities and our state departments and to some degree the reports we must make to the U. S. Office of Education. We have decided to stay with the five classifications but the Handbook II contractors wanted a sixth one i.e., the fiscal year. We might have to change the next three slides in our schema in order to be compatible.

Slide. We think that this should take care of most requirements. If not, it seems appropriate to have boards suggest that certain state laws should be changed. In the function classification we have listed the three items we intend to use. The big city districts urged us to stay with five rather than three. These three are: instructional services, support services, and supplementary services.

Probably we will split support services two ways: support services--instructional, and support services--non-instructional. The non-instructional support services such as transportation, food services, operation and maintenance, could be taken care of at the next level. Also in this slide and as an example we have tried to introduce the idea of the computer usage.

We will probably add one other function to be compatible with Handbook II. It was agreed upon by the national committee last week that in the function dimension we should have instructional services, support services, community services and a fourth which would be called non-funcational transactions and which would take care of outgoing transfers which are so often misunderstood.

Slide. Having taken you now through that first level, I will move you into the second level. At the moment you will find that the function of the instructional services and its category is completely compatible with the handbook revision. In other words, these four categories are exactly as they will appear in Handbook II revision under the function of instructional services.

For those of you who are taking notes, the subdivision of support services at this same level probably will be three fold; namely: pupil personnel services, instructional support and general support. Again, hopefully this part will be compatible with Handbook II (Revised).

Slide. This slide represents the third level in the accounting structure. I was hesitant to leave this slide in the series because this distribution was a point of great controversy at the last meeting of the national committee. It was the feeling that if we left this division of classroom teachers, classroom teaching, and other responsibilities, that we would be placing constraints upon you people within your own districts. For example, if you wished to support the idea of the non-graded classroom or you wished to deal with differentiated staffing within your own school system, for us to set up subdivisions would be a mistake.

If this level was left open-ended so that you could feed back into the regular, occupational, special and continuing education dimensions, you would satisfy your own needs for the most part within the basic processes of the various services and not have any major problems. I have a feeling that this third level example will be abandoned and that this level will be left open-ended. It will be up to us, therefore, in our document to give you a series of case studies that show you different types of program structures and give you examples of implementation. But it will be up to you to develop your own program structure.

Slide. Now I take you into the final component and this is the one that will probably be most difficult to implement. In this particular diagram we are trying to suggest that you consider the learner at the point he is introduced into the program; that you take a look at the objectives which you have established for him and the program you have established for him, and determine where he stands at the point of beginning. In other words you will evaluate him both objectively and subjectively, all of which gives you data, all of which gives you an initial evaluation. The implication here is that you may have prepared a program for a particular group of youngsters and initial evaluation shows that some of the youngsters do not belong. It is better to evaluate at the beginning, find out misplacement, early and do something about it. Again you are reminded on the left hand screen that you should establish evaluation plans for learner activities and support services.

Slide. The picture on the right hand screen suggests that it is a good idea to evaluate part way through a program. In other words, don't wait until the end of the program to see how well he is doing, whether the program established for him is satisfactory, and whether adjustment is needed.

Slide. At the end you take a look at him to see whether the objectives and the program established for him have been effective and you evaluate in terms of outcome. You put it all together and you have an example of what the total process looks like. Again just because we have suggested three points of evaluation does not mean that you have to stay with three. This decision is yours. We do think that the idea of both objective and subjective judgment is sound. We do know that over the years you will accumulate much data. The sound evaluation of this data will certainly lead to sound decision making and modification as necessary.

Slide. You may remember the feedback I told you about this morning, We have recommendations for evaluations beyond just the learner. The picture on the left hand screen and the formula is referring to the establishment of plans for ancillary evaluation. Ancillary evaluation, by way of example, might be the examination and evaluation of educational management, evaluation of personnel, evaluation of facilities, evaluation of supplies and equipment and, finally, the last point which I made a few minutes ago, evaluation of the overall process itself. In terms of project time we cannot predict what it will cost, what it will call for in the way of resources, both money, time, people, and other factors. Is it worth all the effort? We have the responsibility to determine the answer in the evaluation procedure.

Slide. Again we introduce the idea that modification is necessary based upon data we have collected, and, of course, we again introduce the re-cycling procedure.

Slide. I have told you that Chapter 2 basically is built around what you have seen this afternoon. Chapter 2 does not just include the schema; it includes the written word as well. It includes all of these activities amplified to some extent. Again, in trying to listen to the field we have gone one step further and in addition to writing about events and activities we have put together tables at the back of Chapter 2.

Putting the design together and supporting Dr. Bliss in what he said this morning, that even though you have four separate components, they are all part of the integrated whole.

In conclusion, I am going to be repeating something John told you, and you will see it in the document also. It is our opinion that this new approach should result in a more objective look at what we are trying to do in education, how well we have done it, and finally how to go about the process of creating change and improvement.

It is designed to result in better long-range planning, better involvement on the part of the staff, students, community and, therefore, more effective use of resources. We feel that this new approach to the decision-making process should help to build greater support and confidence in our school system on the part of the public. This design, when completed and defined must provide overall patterns for school districts of varying sizes and characteristics to give each room in which to move. I must emphasize the importance to you as I did this morning of developing massive in-service training programs to improve staff involvement in the program. Just as important will be more effective administration at all levels for participation in and encouragment of staff members to participate in these various types of in-service programs.

As you will remember it is rapidly becoming essential that a sound approach to the budgetary and resource allocation processes of the future be based on some sort of a device involving effective identification of resources, establishment of desired goals and objectives, careful program planning, the development of alternate patterns in the decision-making process, more sophisticated methods of allocation and accounting and finally an evaluation program to determine the accomplishment of goals and objectives. Hopefully the aforementioned statement and illustrations will help place effective program planning in proper perspective to this new approach to the decision-making process. Without it a school system, its board of education, and its administration are lending support to the status quo. The greater demand for broadening the scope of our educational programs, the pressures for the negotiative procedure with its great demands of all types, the impact of new ideas in technology, and the greater burden on school systems toward solving our social problems, all suggest the need for the development of a new design which will provide much better long-range planning, much more effective allocation and use of resources. We think that such a design should involve the application of the planning programming budgeting and evaluation systems concept.

SYSTEMS APPROACH TO PROJECT MANAGEMENT

Desmond L. Cook

I. Introduction

The general topic of this workshop is systems, systems theory, systems analysis and related topics. You have also been talking about the world of Management Information Systems. We are going to be talking about a Management Information System which incorporates many systems concepts and is designed to do a particular job which has increased in both popularity and need in the last several years.

I plan to talk about the concept of project management, why we have it, what it is, and how it got started. I want to talk about a management model which is divided into two sub phases, one called planning and the other control. This afternoon you will have some actual exposure to PERT, so what I will do is illustrate my model using PERT because it is a pretty good way of doing so.

Our major interest is the concept of project management. We run into some difficulty because the terms project management, systems management, and program management are all used interchangeably. What we are talking about fundamentally is the integrated management of a specific project on a systems basis. In other words, a look at the total project as a system. This is why the work you've already had in systems concepts becomes very relevant here.

Project management is the ability to pull together all the resources and skills needed to accomplish the job, and more importantly, at least from our point of view, putting all of these under the direction of one person--the project manager. The project manager or the project director, whatever the name you want to give him, should have the authority and responsibility to make the decisions necessary to accomplish the program objectives. His or her success will depend to a great extent on the freedom to be able to move within the project to change things as needed to accomplish the objectives.

Why should we talk about program management? Why should we have this kind of concept? What's involved in it? The things we are doing today in education are much more complex than they used to be. We have gone from the corner grocery stores to the supermarket in terms of educational operations. We are also being asked to innovate and change. There is a lot of pressure for this. If we don't have some way of managing these projects and programs directed at change, they might not get accomplished.

A. What is a Project?

Let me describe for you what I see as a project. A project has an identifiable end product. Basically, it is some goal that we are trying to accomplish. This goal can be many things. It can be a decision itself.

For example, you could undertake a project which has as its end product a decision for a school district to enter into EDF. This would be called a feasibility study, but the end product would be a document which says this is our decision to go ahead or not go ahead. An end product can be a new resource guide in terms of a curriculum unit. An end product might be a process of registration of students. That is, what we are going to do is have a project which will develop for us a way to register our students.

A second characteristic relates to complexity. People, resources, tasks, jobs and everything else have to in some way be integrated and pulled together to get to that end product. Now obviously projects differ in their complexity. Here the concept of simple deterministic systems versus complex probabilistic systems becomes relevant since probabilistic complex projects are much harder to manage than simple deterministic projects.

The third characteristic is that these projects we are doing have uncertainty and risk associated with them. Some people refer to them as "once-through operations." The last characteristic relates to some kind of time frame.

To summarize, ask the questions: Have I got an identifiable end product? A fair set of complex elements in terms of people, resources, and tasks; something largely innovative in the sense that maybe we don't have any past experience--it's a once-through operation? Do I have a terminal date? If you can answer these questions in the positive, then you probably have a situation that is amenable to project management. It's a situation for which a tool like PERT can be applied.

B. Role of the Project Manager

The project manager serves as a focal point or the integrator, for getting all the things done in the project. What I have become particularly interested in is the things which make for effective project/ program management. A project manager will be effective to the extent that he has a background experience in the field of education and in the types of projects which he is asked to direct. The individual would be effective to the extent that he has had time in grade. That is, he has had some opportunities to be in a project manager position previously, such as an assistant project director.

The third factor in effectiveness if training in the area of project management. The last factor would apply to many other kinds of things--the extent to which the individual managing the project has everybody behind him.

C. Projects in Organizational Structures

Let us now take a look at how projects get put into organizational structures since this will help us deal with the nature of project management. There are some general patterns emerging, each with its own limitations and advantages. One pattern is to have the project placed off by itself under the chief official. As long as the project exists, there is a project director. In many cases, he has much independence to operate on his own since he is outside the rest of the structure. Essentially he has a lot of autonomy and a lot of independence. Once the project ends, it visibly disappears and the project director goes on to bigger and better things or to another district and to another project and so on.

One of the major problems such projects have is their working as an independent operation which creates a problem when they try to come into the district and do things.

Another way that projects are placed is to have them in some existing unit. The Title I reading project is placed under the unit which deals with reading within the district. The resources and personnel needed to carry out the project presumably come from that department or at least the people are transferred over for the duration of that particular project. This pattern has certain advantages. Certainly we know the lines of authority, we know who is going to make the decisions, the people know where their reward promotions are going to come from, and so on. This pattern is susceptible to a major limitation and that centers around the idea that maybe the second project comes into that department, maybe a third one, maybe a fourth one. So what you do is have people engaged in "empire building."

The most common pattern, which exists in the government and military and to a great extent, believe it or not, in education, is where the project represents an overlay upon the organizational structure. The project director or project coordinator is named. He is largely responsible for making sure that the job gets done. What he has to do is utilize people, resources, and skills, and talents from other offices within the organizational structure. This pattern has created certain kinds of problems for project management because while the individual is responsible for getting the task done, and he can have a lot of say about when it gets done and what is to be done, he often cannot say how it will be done because the specialists are going to do this. So the functional departments work in their areas, but he has to coordinate the whole ball of wax. In a sense, he has to cut across both the horizontal and vertical structure of the organization.

D. Management Functions

Let me now talk a little bit about the functions of management. Planning is concerned with objective or goal setting and then devising the alternative ways of implementing that particular goal and eventually choosing one of the alternatives and going operational with it. Organization generally refers to creating some kind of structure to help carry out that plan. This might be for example the school structure, the vertical relationships existing between superintendent, principals, and teachers. Controlling generally refers to the fact that once you see a plan into motion you have to have some vehicle to make sure it is being carried out. People use terms like monitoring, review, and so on to talk about the function of control.

Control involves not only sensing, in a sense that you are identifying that something is going wrong, but also taking the necessary corrective action to get it back on track.

What we concentrate upon are the functions of planning and controlling. When you are going to deal with a project or a program you have to plan that program, put it into action, and then constantly check to make sure that it's being carried out.

What we are really looking for is a system of some sort, let's call it a management system, which will help us accomplish certain functions. In this case, the functions we are trying to accomplish are the planning and controlling of a project operation. What we are looking is a kind of system to help us plan and control projects so that we can be effective.

Now, this requirements leads us to what we call a management information system. One of the questions we asked is what kind of data or information is of value to the project/program manager? We put this into three major categories of time, cost, and performance. It is best to think of time-cost-performance not as independent variables but as highly related variables. At some point in time, we can get an optimum mix of these things and then have the project at it's optimum condition.

We can talk in a sense about an optimal project operation but in order to do that we've got to deal with these three variables and recognize some of the problems inherent in them. Let me try to give you one simple example of one case of this. Most of you know the Apollo space program. You also recall Kennedy's statement that we're going to go to the moon in this decade. Kennedy set a time limit. He also said we plan to get a man to the moon and return him safely and thus set a performance standard. The only variable he had left to manipulate was money. He was able to go to Congress and get the needed 24 billion.

One of our major problems in educational project management is that we don't have enough experience with regard to the time it takes to do a job, the performance levels we can expect, or the money it takes to do them. If we did have large amounts of data available to us, then our jobs of project planning and controlling would be much easier. As I say, we are looking for a system which will help us accomplish certain kinds of jobs. We are trying to work up a vehicle, a method of making sure that the guy gets the right kind of information at the right time. We are trying to work up a vehicle, a method of making sure that the guy gets the right kind of information at the right time. We are trying to develop a system which will help force decisions in advance of movement within the project. We're trying to find a way to compare actual verses planned performance. Any system that we develop or employ cannot cost a lot of money to employ.

II. A Project Management System Model

You have been given a paper called "Better Project Planning Through Systems Analysis and Management Techniques." This paper was one of the first attempts to integrate some of these basic ideas. It was first presented at the Operations Analysis in Education Symposium in Washington in November, 1967. Basically, what I said then I still ascribe to in general. Once you understand some idea of the nature of the systems, once you begin to understand some idea of the nature of management, and some idea of the nature of projects, then you can begin to develop a system to plan and control projects. That is all PERT is designed to do. With this as a background, we proceeded to develop the project management system. That is what is represented on the chart in Figure 1.

We want a system which will enable the person to manage the project better than he would if he didn't have such a system. The model shows that there are two major sub-functions in the sense there are two major subsystems. One of these is a planning system and another is a control system. In other words, you have to have something which helps to do a better job of planning and a better job of controlling. So we have these two subsytesms. Then we asked the question "What is involved in planning?"

There are five major tasks which have to be done. In a sense, the output from each of these tasks becomes an input for some subsequent task and also helps provide the kind of data information basis the project manager needs to get the job done. The first major task is defining the project, telling what this project is all about, establishing the objectives, drawing the boundaries around it. You have to draw a boundary around the project to know what tasks are included and what tasks are now excluded. Once that is done, you have to develop some kind of work plan--we refer to this as the work flow. The question becomes to some people "How do I represent that work flow?" Network techniques like PERT are simply one way to show work flow and it operates under certain kinds of rules.

Next, you have to get some idea of how long each job is going to take as well as how long the total project is going to take. The procedure you use here depends upon how well you know what you are doing. If you have done this thing over and over again like building a school building or building a highway then your time estimates are pretty deterministic. Where you have problems is when you go into what are called R & D efforts where a lot of uncertainty exists. Then you need a mechanism, a vehicle to take care of that uncertainty, to build it in, to recognize that you may have failures and have to start all over again. That is why the PERT system uses multiple estimates of time. It is in order to help you deal with the problems of uncertainty in both individual task and total project.

Scheduling is a problem of looking at what kind of resources you have, and when they are going to be available. You can bring a project in the situation and have it start on a certain date but the resources you want may not be available.

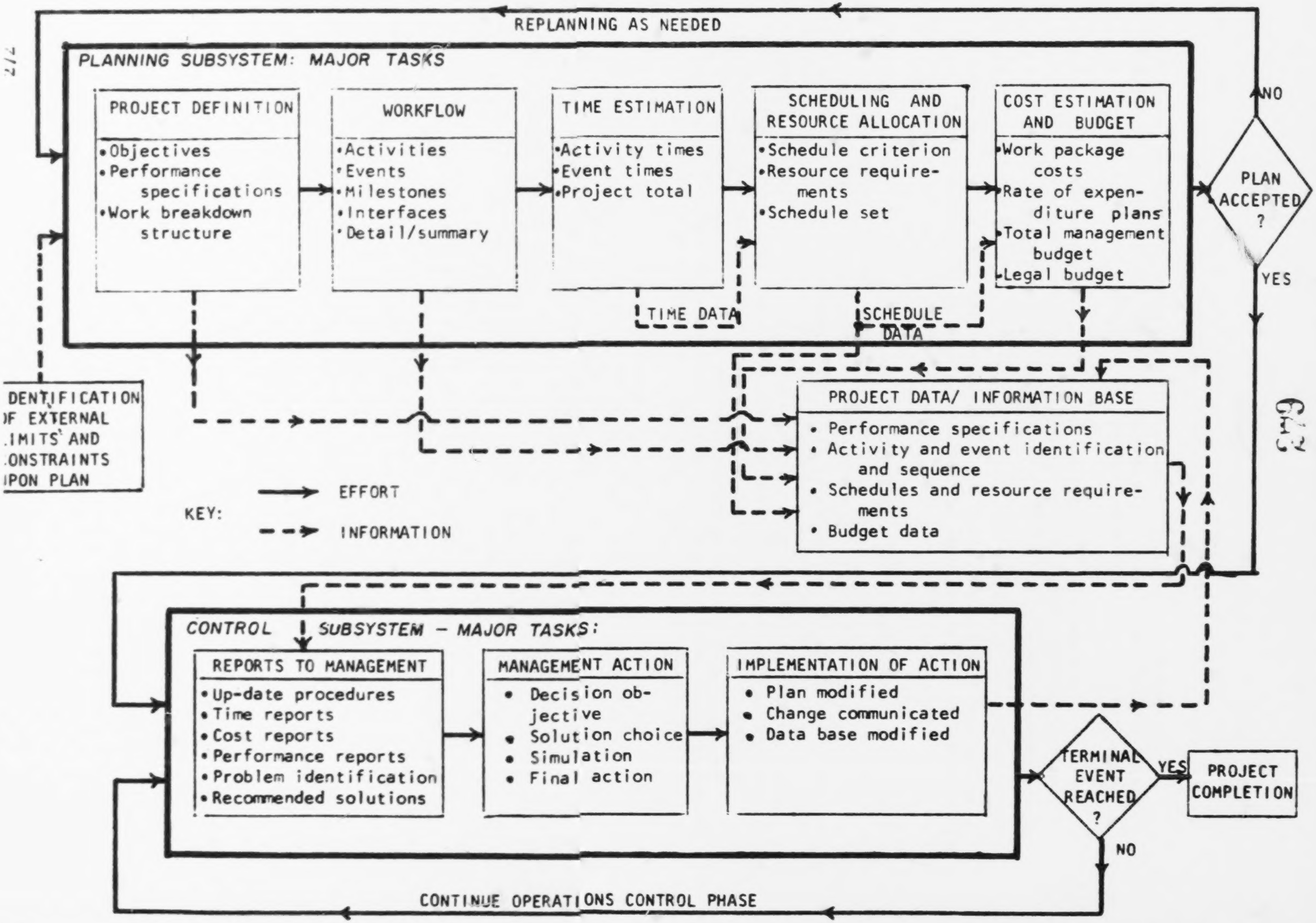
Costing was labeled as the last step, primarily because we look at budgeting basically as a plan for spending money. More importantly, the budget is a translation of your plan over into dollar amounts.

At the bottom of Figure 1, the control subsystem is outlined. The basic vehicle for control is reporting which can take place in many forms. There can be written reports, oral reports, informal conferences, but in

MANAGEMENT SYSTEM FOR PLANNING AND CONTROLLING OF PROJECTS

DESMOND L. COOK

Sept., 1969


REPLANNING AS NEEDED
PLANNING SUBSYSTEM: MAJOR TASKS
PROJECT DEFINITION
•Objectives
•Performance specifications
•Work breakdown structure
WORKFLOW
•Activities
•Events
•Milestones
•Interfaces
•Detail/summary
TIME ESTIMATION
•Activity times
•Event times
•Project total
SCHEDULING AND RESOURCE ALLOCATION
•Schedule criterion
•Resource requirements
•Schedule set
COST ESTIMATION AND BUDGET
•Work package costs
•Rate of expenditure plans
•Total management budget
•Legal budget
TIME DATA
SCHEDULE DATA
PLAN ACCEPTED ?
NO
YES
DENTIFICATION
OF EXTERNAL
IMITS AND
ONSTRAINTS
IPON PLAN
PROJECT DATA/ INFORMATION BASE
• Performance specifications
• Activity and event identification and sequence
• Schedules and resource requirements
• Budget data
KEY:
EFFORT
INFORMATION
CONTROL SUBSYSTEM – MAJOR TASKS:
REPORTS TO MANAGEMENT
•Up-date procedures
•Time reports
•Cost reports
•Performance reports
•Problem identification
•Recommended solutions
MANAGEMENT ACTION
• Decision objective
• Solution choice
• Simulation
• Final action
IMPLEMENTATION OF ACTION
• Plan modified
• Change communicated
• Data base modified
TERMINAL EVENT REACHED ?
YES
NO
PROJECT COMPLETION
CONTINUE OPERATIONS CONTROL PHASE

some kind of way you are trying to have management informed of what is going on in terms of project operations. Specifically, what you are looking for are what we call discrepancies or deviations from what you said you were going to do and what actually happened. Now these deviations can be both positive and negative. You can be doing better and be ahead of schedule. Your performance standards for a class in a project might be that 90 percent of the students will get 90 percent of the items right on a particular exercise. Now as you move through this project you might find 100 percent of the students are getting 90 percent right. You have a positive discrepancy and one ought to recycle on that evidence just as much as he ought to recycle if only 80 percent are getting the items right instead of 90 percent. In the latter case you have negative discrepancy. So you can be ahead of schedule or you can be behind budget and so on.

You have to have some kind of a vehicle which tells you as a manager where the problems are. Obviously you cannot carry out this function properly unless you have something done in the planning stage that tells you what you should have been doing. This is why planning is becoming more and more important. It sets the stage for checking the operations of organizations to make sure they are performing what they want to do. What the report tells you is where the problems are. Once a problem is identified, we have to find out the reason for its occurence. This itself is quite a time consuming process. We have to answer that question before we can take any other action. There are lots of reasons. Once we identify why a deviation exists then we can begin to study alternative solutions.

Once a decision is made then we have to make sure it is implemented. We put a stress on this because we find in a great many cases decisions are made and not implemented, not followed up on, not made sure that they are part of the system. The whole control sequence is built on these three identifiable sub-tasks because we know from experience that reports can be generated and nobody pays any attention to them; problems are identified but nobody is listening for a whole variety of reasons; or maybe the report system is such that it does not flag the problem and therefore nobody can take action.

Notice in Figure 1 that there is a dotted line. If you will look at the key, that dotted line represents information which is being fed to the project data or information base. When I sit down and state my objective and the criteria for the accomplishment of that objective, that becomes part of my data information base for managing the project. In the work flow, the sequence of work is going to generate additional information. It is going to tell you when each job starts, when each job ends, and so on. Then you move over into time estimations where you get the times to do each job. You can use that information to generate for you the times that these particular events are going to take place, or when a job should start and when a job should end as well as the total project time. Notice that the time data does not feed down to the information base. It moves over to the block called scheduling and resource allocation. Why? Because in the planning phase when we do the estimating, we do not consider the realities of scheduling and resource allocation. We make certain assum-tions about the kind of resources we are going to have. When we make the estimate, we assume that we are going to have the resources, so we don't have to worry about that problem. But the reality of life says you do have to eventually get to that problem saying when are the facilities going to be available, when are the people going to be available, what other jobs have we in the shop that we have to account for, and so on.

Butget information comes as the last step. Here we are concerned with the cost of what we call individual work packages. We want you to establish rate of expenditure plans showing an actual graph of how you intend to spend the money over time. We want to have what we call the management or output budget, and we also have to prepare what we call the legal or input budget.

You do all this information generation in the planning phase. Notice what you are generating down here at the bottom--the project data information base. You are going to use that in managing the project. Over at the right you have the question "Has your plan been accepted?" This is like saying, Has your proposal been accepted? If no, then you have to go back and do the replanning. Now maybe it doesn't require complete replanning; maybe you can come back and enter the system just at time estimating or just at scheduling or just at budgeting.

Let us come down to the bottom box or control system. You notice after the planning is accepted, you then go operational. Now we have to carry out these major tasks in this stage. In your reports to management, you have to work up some way to update your project. By update I simply mean report where we are today. You have to work out a system where people feed to you exactly what jobs have been done, which ones have not been done, when they've been completed, and so on. You can prepare a time report, a cost report, and a performance report showing exactly where you are in terms of these three areas. Now these can be combined into one report, so that you can relate time, cost, and performance together. Reports become an imput to management actions. I have to know first of all, what is my goal? What is my own value system? What is it I want to accomplish? Now the objective might be to bring this project in on time, and so my basic decisions are going to be made within a time frame. On the other hand, my basic objective would be that I want to produce the best quality product I can. And time is not one of my major concerns. Therefore, any decision I make will always be in terms of that objective.

The final box leads to implementation. Here is where you modify your plan in terms of the original setup. You communicate the change, and you modify the data base. The dotted line going back now to the information base says any time you change or modify, they you go back and establish a new time schedule, new performance specifications, and so on. They you keep that up until you say, have I reached my terminal event; that is, have I completed my objective. If the answer is yes, you have completed the project; if no, you keep going until you do.

III. Role of PERT

Now what PERT enables you to do is accomplish all of these tasks. PERT is a tool for you to get this job done. What it concentrates primarily upon is the work flow or network. Its second major emphasis is upon time--the planning and controling of time. Now it can be used to include performance and cost because I can relate cost to time, and I can relate cost to work, and I get my work breakdown out of my project definition. So I am able to begin to relate time and cost. Eventually, I have to relate time, cost, and performance all together. This is the context or the situation for which PERT is designed. The specific techniques, the specific rules, are available in almost any standard reference work on PERT.

PROCEDURAL ASPECTS OF PERT TIME ANALYSIS

Kirby L. Madden

Introduction

Conceptual presentation of the topic of systems analysis in my Operations Research class usually results in questions pertaining to its workability. Today I am going to talk about one type of network analysis technique, PERT (Program Evaluation and Review Technique), and illustrate that although complex to some at first examination, it is a very workable and useful managerial tool.

As indicated in the handout, the PERT process consists of a number of major operations. Each of them will be discussed and later applied to an example.

A prerequisite to PERT Analysis, not listed in the handout, is to define the objectives of the project as well as its limits and also the relationship of the project to the overall objectives of the organization. This step was omitted because there is not enough time to consider it and its relationship to the managerial planning function. However, it does bear mentioning.

Creation of the Network

Activity Analysis

In this phase of the PERT process the main objective, much like that of the production planner, is to specify the jobs/operations necessary to accomplish the objectives of the project. In PERT terminology the jobs are referred to as activities, while events designate the start or completion of an activity. In most cases, activities require the use of some or all of the factors of production. The exception to the rule is what is known as the dummy activity. This type, to be exemplified later, is employed to maintain the logic of the network. Though used frequently in PERT problems, this concept is not solely a product of PERT analysis. It is just as popular in the matrix operations of the dynamic programming model.

Theoretically, the number of activities in a project depends upon the amount of detail required by the project planner. The degree of detail, in turn, depends upon the level or amount of control desired, which is a function of the relevance of the project. In other words, activity analysis is similar to the managerial principle or strategic point control which states that the more strategic a point the more control needed. The measurement used to determine the strategic area differs depending upon the organization and the point within that is selected. Note that this principle applies not only to the entire project, but, also, to individual branches in the project.

Arrow Diagramming

Activity analysis is followed by arrow diagramming or flow charting, as it is commonly called. Here, the interrelationship of the activities is pictorially displayed.

Three guidelines prove helpful in determining the position of the activity in the PERT network. They are:

1) what activity must be completed before this certain activity can be initiated?

2) are there any activities that can be performed parallel with this study?

3) what activities succeed this activity?

After sequencing the events, arrows are drawn to depict the activities and to indicate the flow of work through the project. The tail of the arrow represents the start of an activity and the head represents the completion. It should be noted here that in the forthcoming charts the length of an arrow in no way represents the completion time of an activity.

Numbering

In order to distinguish activities each event is numbered. The general rule for numbering is T.N. $<$ H.N. where T.N. is the arrow tail number and H.N. the arrow head number.

Illustration

Before continuing with the steps in the PERT process let's introduce a special construction example which will facilitate understanding of the process. It is far removed from the field of educational administration but serves to illustrate that the technique is quite applicable to those projects meeting the qualifications discussed by Dr. Cook.

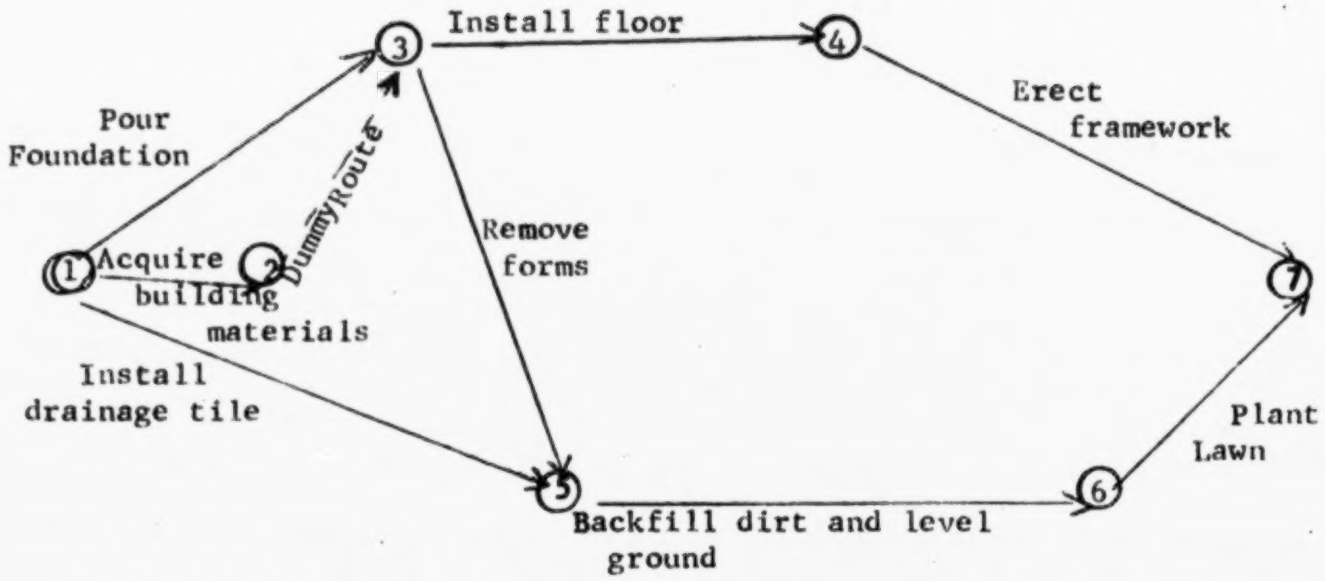
The contractor, in this special project, has agreed to do the following activities:*

1) Pour foundation.
2) Acquire building materials.
3) Plant lawn.
4) Erect Framework.
5) Back fill dirt and level ground.
6) Install drainage tile.
7) Remove forms.
8) Install floor.

Activity analysis, arrow diagramming and arrow numbering result in the following network.

---

* Adapted from the working material of Professor Nicholi Siemens, University of Georgia.


1
2
3
4
5
6
7
Pour Foundation
Acquire building materials
Dummy Route
Install floor
Erect framework
Remove forms
Install drainage tile
Backfill dirt and level ground
Plant Lawn

Each term, I give my Production Management students some preliminary PERT data and ask them to construct a network. Being novices at this type of work, their efforts usually result in all sorts of project configurations which seem unworkable. But as long as the correct activity relationships are represented the network is correct. The "best" shape will depend upon the project controller since he must work with the network and, therefore, is interested in the one that allows for ease of operation.

Estimation of Time Requirements

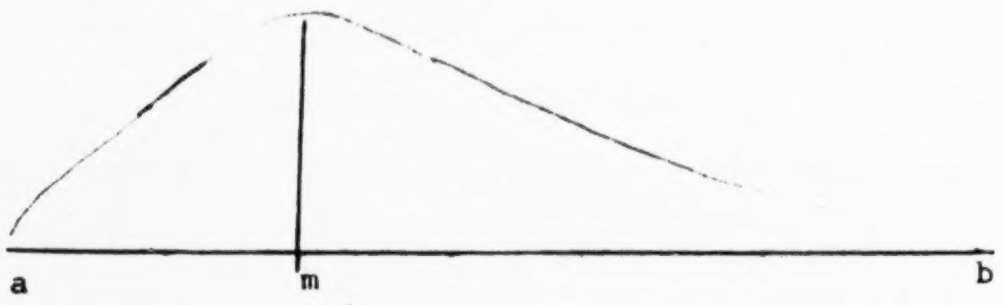
Once the network is constructed the next step is to establish time estimates for each activity. These times are submitted by highly trained and experienced personnel. Three times are submitted for each activity. They are:

A) optimistic time. This is defined as the shortest time possible for an activity.

B) most likely. Usually considered as the model time for an activity.

C) pessimistic. It is the longest completion time for an activity under adverse circumstances.

These time estimates conform to a beta distribution. In the case below a is the optimistic, m the most likely and b the pessimistic time.



Times for the example are depicted in the following chart. In this case the measure of time is days. However, it must be pointed out that the measure of time will vary depending upon the project and the individual activity.

TABLE 1

Activity	t_o	t_m	t_p
1-2	4	7	10
1-3	5	8	11
1-5	4	7	16
2-3	0	0	0
3-4	2	2	8
3-5	2	5	8
4-7	5	8	17
5-6	5	9	19
6-7	2	4	12

Expected time - t_e

Since it is bothersome to manipulate three time estimates for each project activity the next step is to reduce the three estimates to one. This one time estimate is denoted by a variety of names. Among the more commonly used are expected elapse time, average estimate time and mean time.

Although differing in name, the computational process is the same. The t_e is figured by the following formula: $t_e = \frac{t_o + 4t_m + t_p}{6}$. This formula is derived from the beta distribution by considering the most likely time, m and M, the mid-range of the beta distribution weighted 2 and 1 respectively. In the following derivation:

m is the most likely time and

M is the mid range of beta distribution which is $\frac{a + b}{2}$ where a is the optimistic time and b is the pessimistic time.

Weighting m two and M one results in the following formula: $t_e = \frac{2m + \frac{a + b}{2}}{3}$

The simplified version of the preceding is $t_e = \frac{a + 4m + b}{6}$. The computed t_e for each activity of the example is found in Table II.

TABLE II

Activity	t_e
1-2	7
1-3	8
1-5	8
2-3	0
3-4	3
3-5	5

TABLE II Continued

Activity	t_e
4-7	9
5-6	10
6-7	5

Critical Path

The initial focus of PERT analysis is to determine which path is the longest. This longest path is designated as the critical path.

Finding the critical path starts with determining the earliest start, E_s, for each activity in the project. Textbooks define the E_s for the initial activity of a project differently. In our case, however, we will define E_s for activities 1-2, 1-3, and 1-5 as day zero.

The E_s for the remaining activities is computed by adding the t_e of the activity to the preceding activity E_s. Therefore, the E_s for activity 2-3 is day 7, (0 plus a t_e of 7). A problem is encountered in computing E_s when there is an intersection of activities as exemplified at event 3 of the sample network where 1-3 and 2-3 come together.

Using activity 1-3 the E_s is 0, or 8 days, and using activity 2-3 the E_s is 7 plus 0, or 7 days. The rule to use at intersections of this kind is to always select the largest number as the E_s for the subsequent activity or activities. Therefore, the E_s for activities 3-4 and 3-5 is day 8. This problem is encountered in two other places in the example. At event 5 activities 3-5 and 1-5 intersect. If activity 1-5 is used, the E_s for activity 5-6 is 0 plus 8 or day 8, but if activity 3-5 is used the E_s for activity is 8 plus 5 or day 13. Following the rule results in an E_s of day 13 for activity 5-6. The same type of problem is encountered at the destination point, event number 7. Event 7 is the termination point for two paths. If activity 4-7 is considered, the duration of the project is day 20, and if activity 6-7 is used, the ending time is day 28. It is concluded then that the duration of the project is day 28. On the network the E_s for each activity is denoted by a ▭.

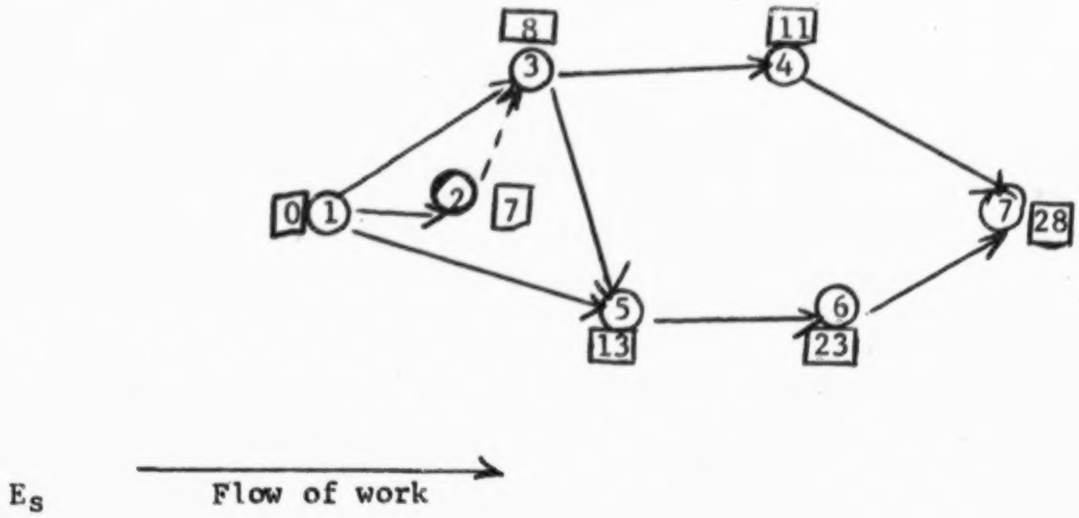


Table III gives the E_s for each of the project activities.

TABLE III

Activity	E_s
1-2	0
1-3	0
1-5	0
2-3	7
3-4	8
3-5	8
4-7	11
5-6	13
6-7	23

The next step in critical path determination is to compute the latest start for each activity. The latest start is the latest time an activity can begin and have this particular path completed on the duration date, in this case 28 days.

To compute the L_s one starts at the termination point with the duration time and from it subtracts the t_e for each preceding activity. Therefore, the L_s for activity 4-7 is day 19 (28-9), 23 for activity 6-7 (28-5), and day 13 for activity 5-6 (23-10).

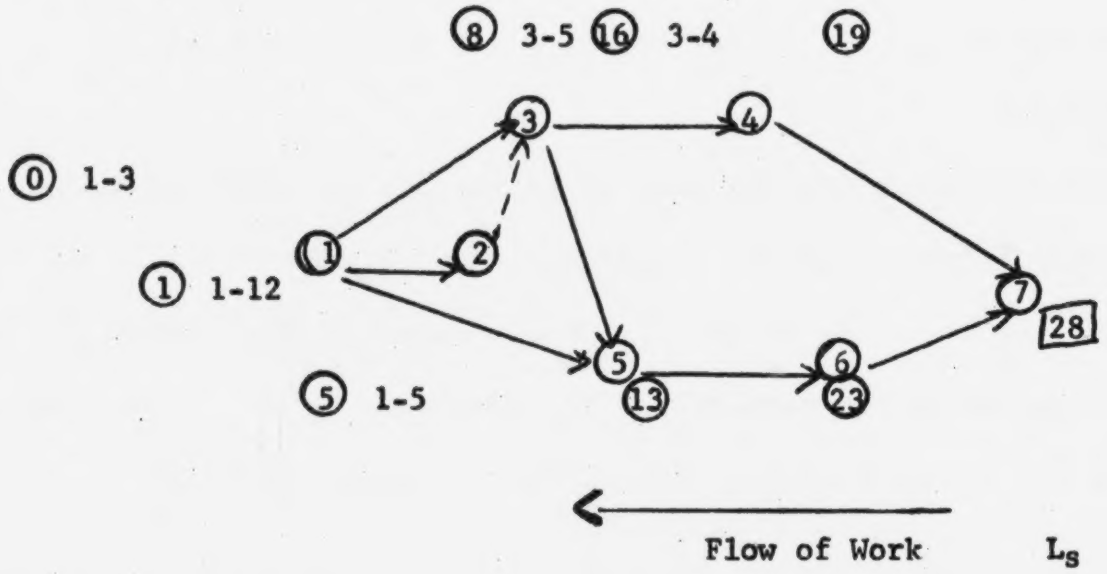
At network intersections, a problem similar to the one in computing E_s is encountered. At event 3 two activities intersect. Activity 3-4 has a L_s of day 16, and activity 3-5 has a L_s of day 8. In all cases of this nature the smaller number is selected as the minuend for the remaining t_e's. Consequently the L_s for activity 2-3 is day 8 (8-0). The L_s for activity 1-3 is day 0 (8-8).

Table IV gives a list of all relevant activity L_s.

TABLE IV

Activity	L_s
1-2	1
1-3	0
1-5	5
2-3	8
3-4	16
3-5	8
4-7	19
5-6	13
6-7	23

The network, with the L_s denoted by a o is:



Now that E_s and L_s for all activities have been computed the next step in critical path determination is to figure slack or free time. Slack is computed by subtracting activity E_s from activity L_s. Although critical path activities can be defined in a number of ways, our concern will be with activities that have zero slack.

Table V indicates the computed slack time for our example. From this we see that activities 1-3, 3-5, 5-6, and 6-7 have zero slack and, therefore, are defined as critical path activities.

TABLE V

Activity	E_s	L_s	Slack
1-2	0	1	1
1-3	0	0	0
1-5	0	5	5
2-3	7	8	1
3-4	8	16	8

TABLE V (continued)

Activity	E_s	L_s	Slack
3-5	8	8	0
4-7	11	19	8
5-6	13	13	0
6-7	23	23	0

PERT Probability

Could our project have an actual completion time of 26 days, 29 days or 30 days? The answer is yes since our computed 28 day completion is an educated guesstimate. Since the actual completion time can vary from the planned time, we talk about a probabilistic path time. In other words, we are interested in the probability that our duration time will be day 26 or day 30.

Each activity is assumed to have a probability distribution for its time estimates. Actual deviation from the expected completion time of each path is considered to be a random variable with a normal distribution. Since each path has an associated probability distribution, it is possible to assign time to activities and then figure the probability of meeting their scheduled completion time.

Most importance is usually placed on the probability of meeting scheduled completion time of the critical path. Computing this probability involves computing variance for each activity, cumulative variance, activity standard deviation and cumulative standard deviation.

The formula used to compute activity variance is:

$$\hat{}^{\,2} = \left[\frac{t_p - t_o}{6}\right]^2$$

Where: t_p = Pessimistic time

t_o = Optimistic time

Next, the variances for the critical path are summed and the square root taken of the total. This yields the standard deviation of the critical path. The preceding is depicted in the following standard deviation formula.

$$\sigma\ cp = \sum(V_{1cp} + V_{2cp} + V_{3cp} + \ . \ . \ . \ V_{ncp})$$

where:

n = activity number

cp = critical path

V = Variance

In some cases it may be necessary to compute variances for all activities. However, in our example we are interested in variance only on the critical path. Table VI indicates the relevant example variances.

TABLE VI

Activity	2
1-3	1
3-5	1
5-6	5.44
6-7	2.77

Next the variances on the critical path are summed. This yields a σ^2 of 10.21 days and a σ_c (cumulative standard deviation) of approximately 3.2 days.

With the groundwork laid we are now able to compute the probability of meeting a scheduled completion time. The scheduled completion time, T_{Do}, is a time usually set by somebody external to the project planning group, and it must be met or suffer the consequences of a penalty cost. In the example, if I demand the contractor to finish the project in 26 days, this time becomes the T_{Do}. A relevant section added to the construction contract is that if the 26 day period is exceeded, the contractor's fee is reduced by a specified dollar amount per exceeded day.

Since path times are assumed to approximate the normal distribution, the probability of meeting this T_{Do} of 26 days is computed by the following formula:

$$Z = \frac{T_{Do} - Te_{cp}}{\sigma c_{cp}}$$

In this formula the critical path Te_{cp} is the expected time of the critical path and σc_{cp} is the cumulative standard deviation on the critical path. The value is the relevant difference between T_{Do} and Te_{cp} in terms of the standard deviation of the critical path. In other words it gives a way of measuring the relevance of the two day difference. Another way of defining it is how many standard deviations does the difference represent.

Computing Z for the example given, results in:

$Z = \frac{26 - 28}{3.2}$ or $Z = \frac{-2}{3.2}$ which equals -.62. This number is then looked up in a normal table which is the last page in your handout. This yields a value of .2324. If the computed Z value is negative, as it is in the example, the normal table value is subtracted from .5 and if it is positive it is added to .5. In our case the final probability value is .2676 (.5 - .2324).

Is this probability figure of .2672 or any other PERT probability figure significant? To arrive at an answer Project Managers usually determine some acceptable probability range. It is important to note here that this range usually differs with each organization. If for example the project's acceptable range is from .3 to .7, the critical path with the probability of .2676 falls outside this acceptable range. To correct this siutation the project manager can reallocate resources from activities or paths that have positive probabilities, work men and machines overtime, or talk to the controlling body and try to get the T_{Do} changed.

Ascertaining positive probability activities necessitates setting a T_{Do} for every activity in the network as well as computing its respective probability. If resources are transferred in the project or if overtime is employed, the PERT procedure may have to be repeated since these alternatives may cause deviations from the planned activity time (t_e) and subsequent expected project completion time. Such tactics may cause another path to become critical. It must be pointed out here that even though some activities may have positive probabilities the work must be similar if resources are to be transferable.

Since we are still in the planning stage of this sample project, the manager now has a decision to make. Given the expected completion time, the scheduled completion time and the probability of meeting the schedule, does he accept the job. He is aware of the probable mechanism cost necessary to meet the T_{Do} of 26 days as well as the penalty cost for exceeding the T_{Do}. The choice then becomes a purely economic one.

If the project is accepted by the contractor he can then use PERT as a control device. He can compare actual activity time with the planned activity time, t_e, and correct the remainder of the project if there is deviation from the planned time scheduled. If deviation occurs, the control process would entail recomputing the remaining parts of the network.

Conclusion

During the past two hours, I have attempted to convey not only the computational aspects of PERT but also the usefulness of PERT as a dynamic planning and control device. I hope that you have the opportunity to use if effectively in your work.

APPENDIX

PARTICIPANTS NAMES AND ADDRESSES

EDUCATIONAL RESEARCH TRAINING PROGRAM IN MANAGEMENT TOOLS FOR EDUCATIONAL RESEARCH LEADERS

PARTICIPANTS
Oct. 6-10, Dec. 8-12, Jan. 12-16

ALABAMA

Atwell, Charles A.	Auburn University Asst. Prof. of Educ.	Dec. 8-12
Jones, Ralph W.	University of Southern Alabama Director of Research	Oct. 6-10
Watkins, James F.	Auburn University Asst. Prof./Field Representative	Jan. 12-16

ARIZONA

Anderson, Keith Waldo	University of Arizona E. Ad./Dir. Bureau of Ed. Res. & Svc.	Dec. 8-12
Deever, Merwin R.	Arizona State University Dir. Bur. of Ed. Res. & Svc.	Jan. 12-16
Demeke, Howard J.	Arizona State University Assoc. Prof./Ed. Adm. & Sup.	Jan. 12-16
Smith, Joe C.	State Dept. of Public Inst. Phoenix, Arizona	Jan. 12-16

ARKANSAS

Reese, Clyde	State College of Arkansas Chairman, Dept. of Psych. & Counselor Education	Oct. 6-10

CALIFORNIA

Banathy, Bela H.	Far West Lab for R & D, Berkeley	Oct. 6-10
Brown, Stanley B.	Calif. St. Polytech. College Res. Coord. Minority Educ.	Dec. 8-12
Leavitt, Jerome E.	Fresno State College Prof. and Head Dept. of Educ.	Dec. 8-12

California cont'd

Nelson, Jerald W.	University of the Pacific Dean of Inst. Res. & Records	Oct. 6-10
Newell, Dwight H.	San Francisco State College Dean of School of Educ.	Jan. 12-16
Shay, Carleton B.	Calif. St. College, L.A. Assoc. Dean-Educ. and Coord. of Grad Study	Dec. 8-12
Still, Richard C.	Stanford University Asst. Dean, School of Educ.	Oct. 6-10
Thomas, Jack E.	Stanford University Administrative Officer, Center for Res. Development	Oct. 6-10

CONNECTICUT

Livak, Frank Howard	Connecticut St. Dept. of Educ. Education Consultant	Dec. 8-12

FLORIDA

Edgar, David E.	Orange County School Board Dir., Proj. #6325/Pub. Sch. Res.	Jan. 12-16
Jacobs, John F.	University of Florida Asst. Prof. - Spec. Ed. and Child Psych.	Dec. 8-12

GEORGIA

McGuffey, Carroll W.	University of Georgia Prof. & Dir. Ed. Planning & Dev. Studies	Jan. 12-16

IDAHO

Wicklund, Lee A.	Idaho State University Asst. Prof. Ed. Ad.	Jan. 12-16

ILLINOIS

Bowen, Robert	Wabash Comm. Unit Sch. (Mt. Carmel) Superintendent of Schools	Dec. 8-12
D'Amico, Louis A.	Northeastern Ill. St. College Dir., Res. & Dev.	Oct. 6-10

Illinois cont'd

Hedlund, H. Jean	Chicago State College Dean of Administration	Jan. 12-16
Kirkhus, Harold P.	Peoria Public Schools Dir. of Research	Oct. 6-10
Milnor, Brent	Mt. Zion Comm. Unit Schools Principal	Oct. 6-10
Norwood, Donald C.	Office of the Sup. of Pub. Inst.	Oct. 6-10
Owens, Wayne S.	Eastern Ill. University Adm. Assoc., Office of the V.P. for Development	Oct. 6-10
Rudolph, James T.	Glenbard Twp. High School Dist. 87 Dir. of Special Services	Dec. 8-12
Weidhuner, Robert H.	Eastern Ill. University Asst., Admin. Studies	Jan. 12-16

INDIANA

Jerry, Robert H	Dept. of Public Inst., Ind. Deputy St. Superintendent	Oct. 6-10
Young, John F.	Fort Wayne Comm. Schools Assoc. Superintendent	Dec. 8-12

IOWA

Grosz, Willard W.	Iowa State University Adm. Asst. to the Dean, College of Educ.	Oct. 6-10
Mitchell, James E.	Iowa St. Dept. of Pub. Inst. Dir., MSEIP	Jan. 12-16
Sister Mary Helen, CHM	Marycrest College President	Jan. 12-16

KANSAS

Anderson, Robert E.	Wichita State University Dir. of Educ. Field Service	Jan. 12-16
Dean, Harry	Kansas St. Dept. of Educ. Dir., Information Systems	Oct. 6-10
Hopson, James A.	Mid-Cont. Reg. Ed'l Lab Assoc. Dir., Admin.	Dec. 8-12

Kansas cont'd

Koos, Eugenia M.	Mid-Cont. Reg. Ed'l Lab Research Specialist	Dec. 8-12
Miller, Raymond L.	University of Kansas Asst. Prof. Educ. Ad.	Dec. 8-12

KENTUCKY

Gibson, Charles H.	Eastern Kentucky Univ. Asst. Dean, College of Educ.	Dec. 8-12
Patterson, Charles	Louisville School System Admin. Asst. to Sup.	Dec. 8-12
Wilburn, R. G.	Kentucky Child Welfare Fndn., Inc. Research Associate	Jan. 12-16

LOUISIANA

Blackmon, C. Robert	University of Southwestern La. Assoc. Prof. of Educ., Coord.	Oct. 6-10
Firnberg, James Wallace	Louisiana St. Univ. System Asst. Prof. of Ed. Coord. Inst. Research	Jan. 12-16

MARYLAND

Self, Melvin L.	Maryland St. Dept. of Ed. Consultant in Ed. Tech.	Oct. 6-10
Wall, Robert E.	Towson State College Dir. of Res. & Evaluation	Jan. 12-16

MICHIGAN

Erskine, Edward J.	Macomb County Comm. College Dean of Academic Services	Jan. 12-16
Remick, Edward L.	Lansing School District Dir. of Res. and Facility Planning	Jan. 12-16

MINNESOTA

Burland, Ronald	Minn. St. Dept. of Educ. Dir., Professions Development Section	Dec. 8-12
Carlson, Raymond P.	Bemidji State College Dir. of R. & D.	Jan. 12-16

MISSOURI

Miller, Leon F.	Northwest Missouri State College Dean of Graduate Studies	Oct. 6-10

NEVADA

Loveless, E. E.	University of Nevada Assoc. Prof., School Ad.	Dec. 8-12

NEW HAMPSHIRE

Austin, Gilbert	Univ. of New Hampshire Dir., Bur. of Ed. Res. & Testing	Dec. 8-12
Barker, Richard L.	N. H. St. Dept. of Educ. Dir. N. H. RCA-V.T.	Jan. 12-16

NEW MEXICO

Bollmer, Barbara	Western New Mexico Univ. Assistant Registrar	Jan. 12-16
Dennis, David M.	Western New Mexico Univ. Dir. Res. Computer Center	Oct. 6-10

NEW YORK

Andrews, James	Syracuse University Asst. Dir. School Svc. Bur.	Dec. 8-12
Assarelli, Joseph	New York Univ. Dir., Ed. Res. Suc.	Oct. 6-10
Howell, Edgar N.	N. Y. St. Dept. of Educ. Chief, Bur. of Urban and Comm. Programs Evaluation	Oct. 6-10
Jungherr, J. A.	Pearl River School District Asst. Supt. - Business	Dec. 8-12
Lohman, Maurice A.	City Univ. of N. Y. Assoc. Prof., I. R. & Program Eval. Center	Oct. 6-10
Samph, Thomas	Syracuse University Res. Coord., School of Ed.	Dec. 8-12
Shea, James F.	Suffolk Reg. Educ. Center Assistant Dir. of SCRC	Jan. 12-16

NORTH CAROLINA

Davis, Jr., John B.	East Carolina University Dir., Inst. Research	Oct. 6-10
Johnson, Scott	N. C. Board of Higher Educ. Systems Analyst	Jan. 12-16

NORTH DAKOTA

Sholy, George I.	Wahpeton P. S. #37 Supt. of Schools	Jan. 12-16

OHIO

Hornbostel, Victor O.	Bowling Green St. University Dir. of Grad Studies in Educ.	Jan. 12-16
Rodgers, William A.	Kent State University Dir. Office of Res. Studies & Services	Oct. 6-10

OKLAHOMA

Helton, H. L.	Northeastern State College Dir. of Res. and Development	Dec. 8-12
Weber, Charles L.	Oklahoma St. Board of Educ. Dir. of Finance	Oct. 6-10

OREGON

Jones, John E.	University of Oregon Asst to the Dir., Center for Adv. Study of Educ. Admin.	Oct. 6-10

PENNSYLVANIA

Champagne, David W.	University of Pittsburgh Asst. Prof./School of Educ.	Oct. 6-10
Laverty, Grace E.	Penn. Dept. of Educ. Educ. Res., Assoc.	Oct. 6-10
Sharkan, William W.	Bethlehem Area School District Dir. of Research	Jan. 12-16
Smith, James W.	Univ. of Pittsburgh Manager, Support Services, Learning Res. and Dev. Center	Oct. 6-10

SOUTH CAROLINA

Hendrichs, C. E.	University of South Carolina	Oct. 6-10

SOUTH DAKOTA

Rustad, H. C.	University of South Dakota Asst. Prof. School Admin.	Dec. 8-12

TENNESSEE

Petry, John R.	Memphis State University Res. Assoc./Asst. Prof.	Jan. 12-16
Whittle, James W.	Freed-Hardeman College Inst. & Dir. of Data Proc.	Jan. 12-16

TEXAS

Aldrich, Wilmer W.	Texas A & I University Prof. of Ed. Chairman	Dec. 8-12
Clark, Lester L.	Texas Education Agency Program Dir., Div. of Assessment and Evaluation	Oct. 6-10
Sanders, Stanley G.	University of Houston Assoc. Prof. & Ad. & Supervision	Dec. 8-12
Truax, William E.	East Texas St. University Dean, School of Educ.	Jan. 12-16

UTAH

Merrill, David M.	Brigham Young University Dir., Inst. Res. & Dev.; Chairman, Ed. Psych.	Jan. 12-16

WASHINGTON

Moe, Richard D.	Pacific Lutheran University Dean, College of Prof. Studies	Jan. 12-16

WEST VIRGINIA

Bost, William A.	Appalachia Educ. Laboratory Deputy Director	Jan. 12-16
Goodwin, Harold I.	West Virginia University Chairman, Dept. of Ed. Adm.	Oct. 6-10